WRDC-TR-90-4072

THE MECHANICAL PROPERTY DATA BASE FROM AN AIR FORCE/INDUSTRY COOPERATIVE TEST PROGRAM ON ADVANCED ALUMINUM ALLOYS

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June 1990

Interim Report for Period July 1986 - January 1990

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UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

AD-A226-410

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED	1b RESTRICTIVE MARKINGS
2a SECURITY CLASSIFICATION AUTHORITY	3. DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution unlimited.
2b DECLASSIFICATION/DOWNGRADING SCHEDULE	
4 PERFORMING ORGANIZATION REPORT NUMBER(S) WRDC-TR-90-4072	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a NAME OF PERFORMING ORGANIZATION Materials Laboratory Wright Patterson 6b. OFFICE SYMBOL (If applicable) WRDC/MLSE	7a. NAME OF MONITORING ORGANIZATION
6c ADDRESS (City, State, and ZIP Code) Wright Patterson AFB OH 45433-6533	7b. ADDRESS (City, State, and ZIP Code)
8a NAME OF FUNDING/SPONSORING ORGANIZATION 8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c ADDRESS (City, State, and ZIP Code)	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 62102F; PROJECT NO. 2418; TASK NO 07; WORK UNIT ACCESSION NO. 03

11 TITLE (Include Security Classification)
The Mechanical Property Data Base From an Air Force/Industry Cooperative Test Program on Advanced Aluminum Alloys

12 PERSONAL AUTHOR(S)
Mary Ann Phillips Steven R Thompson

13a TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Interim	FROM 7/86 TO 1/90	June 1990	197

16 SUPPLEMENTARY NOTATION

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP
11	04	

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Aluminum-Lithium, AL905XL, Compression, Fracture Toughness, 2091, CW67, Bearing, Fatigue Crack Growth, 8090, 7064, Shear, P/M, IN905XL, Tensile, Spectrum

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

Development of a mechanical property data base on Pechiney aluminum-lithium structural alloys is detailed. Aluminum-lithium alloys tested were 2091-T3 sheets, 2091-T8X sheets, 2091-T351 plates, 2091-T8X plates, 2091-T6 forgings, and 8090-T651 T-extrusion. Basic mechanical property data consists of tension, compression, bearing, shear, and fracture toughness. Fatigue data were developed for both smooth and notched specimens. Constant amplitude fatigue crack growth rate data and spectrum test data was performed on most products. Corrosion characteristics were also obtained. All other data developed by the participants are documented.

20 DISTRIBUTION/AVAILABILITY OF ABSTRACT	21. ABSTRACT SECURITY CLASSIFICATION
☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	UNCLASSIFIED

22a NAME OF RESPONSIBLE INDIVIDUAL	22b. TELEPHONE (Include Area Code)	22c. OFFICE SYMBOL
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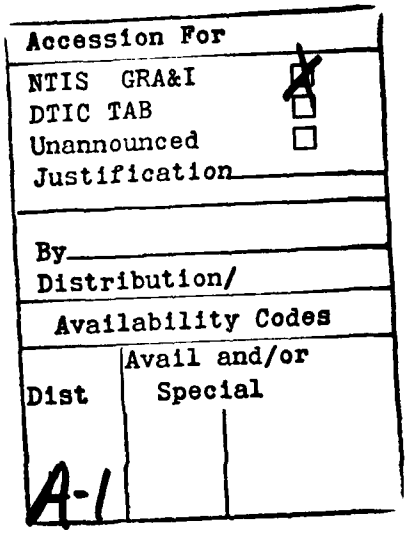
DD Form 1473, JUN 86 Previous editions are obsolete. SECURITY CLASSIFICATION OF THIS PAGE

PREFACE

This report was prepared by the Materials Engineering Branch (WRDC/MLSE), Systems Support Division, Materials Laboratory, Wright Research and Development Center, Wright Patterson Air Force Base, Ohio, under Project 2418, "Metallic Structural Materials," Task 241807, "Systems Support," Work Unit 24180703, "Engineering and Design Data."



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SECTION I

INTRODUCTION

High performance aerospace systems are dependent on materials that are lighter, have improved mechanical properties, and/or offer a cost savings. Aluminum alloys that met this criteria were the newly developed aluminum-lithium alloys and the second generation powder metallurgy alloys.

In 1985 the Air Force along with the aerospace community found it important to investigate the potential of these promising aluminum alloys. A cooperative program was formed by the WRDC Materials Laboratory, Systems Support Division and a number of aerospace industries. The Air Force would obtain the test material from the producers, compile the test data, and submit reports to the participants. The participants agreed to support the program by performing mechanical property tests which includes tension, compression, bearing, shear, fracture toughness, and fatigue related properties (S/N, da/dn). The Air Force elected to perform spectrum fatigue crack growth testing on most alloys. A list of participants is shown in the following table.

This interim report contains only the aluminum-lithium alloys produced by Pechiney: 2091-T3 sheet 0.063 inch thick, 2091-T351 plate 0.42 inch thick, 2091-T6 forging, and 8090-T651 T-extrusion. Comparisons to other materials, and ranking of materials is generally avoided since each potential application may be baised on different evaluation criteria.

TABLE
Participants and Advanced Aluminum Alloys
in the Cooperative Test Program

PARTICIPANTS	ALUMINUM LITHIUM ALLOYS												P/M ALUMINUM ALLOYS					
	PECHINEY				ALCAN	IncoMAP		ALCOA					KAISER		ALCOA			
	2091-T3 Sheet (0.063"T)	2091-T351 Plate (0.420"T)	2091-T6 Forging	8090-T651 T-extrusion	8090-T651 Extrusion	PM IN905XL Forging	PM AL905XL Forging	2091-T3 Sheet (0.063"T)	2091-T3 Sheet (0.144"T)	2091-T8 Plate (0.50"T)	8090 Extrusion		7064-T74511 Extrusion	7064-T7 Forging	CW67 Sheet (0.063"T)	CW67 Plate (0.40"T)	CW67 Extrusion	CW67 Forging
AVCO, TN	X							X										
Wyman-Gordon							X											
Boeing, WA	X	X	X	X														
Douglas Aircraft, CA							X	X	X	X	X							
General Dynamics, CA	X	X						X	X	X								
General Dynamics, TX	X	X	X	X		X		X	X	X	X							
Grumman Aerospace, NY	X	X			X	X							X	X			X	X
Lockheed, CA	X			X			X	X		X								
Lockheed, GA			X		X			X	X					X				X
LTV, TX	X			X		X	X	X			X		X	X			X	
Martin Marietta, LA	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X
McDonnell Douglas Astro, CA									X									
McDonnell Douglas Helicopter, AR							X											X
MCAIR, MO	X					X	X	X						X	X			X
NASA, VA					X	X	X											
Naval Air Development Center		X		X			X			X								X
Northrop, CA	X	X	X		X	X	X	X	X	X	X							
Sikorsky, CT						X		X						X			X	X
Jet Propulsion, CA							X											
Air Force WPAFB, OH		X			X		X	X	X	X	X		X	X	X	X	X	X

SECTION II

MATERIALS AND TESTS

The aluminum-lithium alloys tested were 2091 which was developed for maximum damage tolerance and 8090 which is a damage tolerant, higher strength alloy.

Basic mechanical tests including fatigue, fatigue crack growth, spectrum fatigue, and stress corrosion tests were performed by the participants. ASTM standards were used for testing when applicable.

SECTION III

PRESENTATION

The purpose of this effort was to generate mechanical property data on newly developed aluminum alloys.

Each participant compiled a data package which contained the data they generated. Some of these data packages contain discussions and in other cases only the data were provided. The tensile, compression , bearing, shear, and fracture toughness data from each package were put in tabular form. Fatigue, fatigue crack growth, and spectrum fatigue crack growth data were placed in tabular and graphical form. Corrosion results were prepared in tabular and written descriptions.

Constant amplitude fatigue crack growth tests were conducted according to ASTM E647 Standard unless otherwise specified. The A-N data supplied were reduced using a seven-point incremental polynomial method. This involves fitting a second-order polynomial (parabola) to sets of seven successive data points. K-increasing (load increasing) method. The most often used spectrums were FALSTAFF and Mini-TWIST. Corrosion results were documented almost exactly as they were received from the participants.

SECTION IV

RESULTS AND DISCUSSIONS

This interim report contains only the aluminum-lithium material produced by Pechiney. There are four appendices to this report. Each appendix contains the results for a specific alloy and product form. The following table lists the form, aluminum-lithium alloy and the appendix for the four combinations.

Table
Contents of Appendices

Form	Aluminum-Lithium Alloy	Appendix
Plate	2091-T351 and 2091-T8X	A
Sheet	2091-T3 and 2091-T8X	B
Forging	2091-T6	C
T-Extrusion	8090-T651	D

Some of the alloys were re-heat treated by the participant from the T3 condition to a temper that would give them the optimum properties of their interest. The procedures used for tempering are included on the second page of each appendix.

SECTION V

CONCLUSIONS

Eleven aerospace laboratories participated in generating data on the Pechiney aluminum-lithium materials for the cooperative test program. These data combined with future interim reports on the Air Force/Industry Cooperative Test Program on Advanced Aluminum Alloys will provide an extensive data base on aluminum-lithium alloys.

APPENDIX A

PECHINEY 2091-T351 AND 2091-T8X PLATE (0.42" X 39" X 39")

INTRODUCTION

The Pechiney 2091-T351 0.42-inch plate was received the second quarter of 1986. Some participants heat treated the 2091-T351 to a T8X temper. Three participants heat treated the plate to a T8X temper; Northrop - T8 condition was achieved by aging the 2091 plate at 275° for 12 hours, Grumman (-T8X) at 275°F for 12 hours, and General Dynamics, TX (-T851) at 335°F for 16 hours.

TESTING

Basic mechanical properties (tension, compression, bearing, etc.) were tested according to ASTM standards, unless otherwise specified.

Constant amplitude fatigue crack growth tests were conducted according to ASTM E647 standard. The growth rate a-N data that was generated by the participants (Northrop, Grumman, General Dynamics CA, and Air Force) were reduced using a seven-point incremental polynomial method. This involves fitting a second-order polynomial (parabola) to sets of seven successive data points. The data are also checked against size requirements per ASTM E647, Section 7.2. General Dynamics, TX performed constant amplitude fatigue crack growth tests using a K-increasing (load increasing) method.

Spectrum tests were performed by the Air Force using FALSTAFF (a severe fatigue environment) and Mini-TWIST (a moderately intense fatigue environment) spectrums.

PECHINEY

2091-T351 PLATE

TABLE A1

TENSILE RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
BOEING, WA	RT	LONG	64.5	51.3		17.0	
			64.5	51.2		16.0	
			64.6	51.4		17.0	
GENERAL DYNAMICS, CA	RT	LONG	64.3	51.3	10.2	20.2	10.8
			63.8	53.7	12.4	23.1	10.9
			63.9	51.0	12.5	25.8	10.9
			64.3	50.8	10.2	20.0	11.4
NADC	RT	LONG	68.2	55.5	15.0		11.2
			67.9	57.0	16.0		10.4
			68.2	55.2	15.0		11.7
			67.9	56.5	16.0		10.7
NORTHROP	RT	LONG	66.7	54.7	10.6	18.5	11.3
			67.3	55.2	11.0	18.1	11.3
			66.9	54.8	11.3	19.5	11.7
MARTIN MARIETTA, LA	RT	LONG	64.9	52.1	15.0	15.0	
			64.5	52.7	14.0	14.0	
			64.7	52.3	15.0	13.0	
		AVERAGE	65.9	53.6	13.2	18.6	11.1
	STANDARD DEVIATION		1.7	2.1	2.2	3.8	0.4

TABLE A2

TENSILE RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
BOEING, WA	RT	L TRANS	64.5	44.8		20.0	
			65.3	45.6		18.0	
			64.8	45.5		19.0	
GENERAL DYNAMICS, CA	RT	L TRANS	64.7	46.3	13.8	21.9	11.0
			64.4	46.5	13.4	24.4	11.1
			64.6	46.7	15.9	22.1	10.9
			65.2	47.?	14.2	22.2	11.2
NADC	RT	L TRANS	67.9	50.9	15.0		10.3
			66.2	49.9	16.0		11.7
			67.3	49.9	16.0		12.2
			66.2	49.9	15.0		10.7
NORTHROP	RT	L TRANS	67.2	49.1	12.1	23.4	11.7
			67.7	49.1	12.4	22.0	11.7
			67.6	49.0	12.8	24.8	12.3
MARTIN MARIETTA, LA	RT	L TRANS	65.8	46.6	16.0	15.0	
			65.4	46.0	20.0	17.0	
			65.2	46.6	18.0	15.0	
		AVERAGE	65.9	47.6	15.0	20.4	11.3
	STANDARD DEVIATION		1.2	1.9	2.2	3.3	0.6

TABLE A3

COMPRESSION RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
BOEING, WA	RT	LONG	42.7	
			42.8	
			42.6	
GENERAL DYNAMICS, CA	RT	LONG	42.0	11.4
			41.7	11.6
			41.6	11.7
NADC	RT	LONG	44.7	
			44.7	
			42.3	
			43.9	
			45.5	
			47.3	
			47.3	
MARTIN MARIETTA, LA	RT	LONG	44.5	12.4
		AVERAGE	43.8	11.8
		STANDARD DEVIATION	1.9	0.4

TABLE A4

COMPRESSION RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
BOEING, WA	RT	L TRANS	48.7	
			48.6	
			48.8	
GENERAL DYNAMICS, CA	RT	L TRANS	41.1	11.4
			48.4	11.6
			48.0	11.7
NADC	RT	L TRANS	50.9	
			49.9	
			49.4	
			47.2	
			52.8	
			47.7	
			51.7	
MARTIN MARIETTA, LA	RT	L TRANS	51.6	12.5
		AVERAGE	48.9	11.8
		STANDARD DEVIATION	2.8	0.5

TABLE A5

RIVET SHEAR RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
GENERAL DYNAMICS, CA	LONG	34.3
		33.9
		33.4
	AVERAGE	33.9
	STANDARD DEVIATION	0.5

TABLE A6

RIVET SHEAR RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
GENERAL DYNAMICS, CA	L TRANS	32.6
		36.6
		33.0
	AVERAGE	34.1
	STANDARD DEVIATION	2.2

TABLE A7

AMSLER DOUBLE SHEAR RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
BOEING, WA	L-S	35.2
		35.3
		35.2
	AVERAGE	35.2
	STANDARD DEVIATION	0.1
BOEING, WA	L-T	38.2
		38.0
		37.9
	AVERAGE	38.0
	STANDARD DEVIATION	0.2
BOEING, WA	T-S	34.4
		34.0
		34.5
	AVERAGE	34.3
	STANDARD DEVIATION	0.3
BOEING, WA	T-L	38.0
		38.0
		37.9
	AVERAGE	38.0
	STANDARD DEVIATION	0.1

TABLE A8

BEARING RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING, WA	LONG	1.5	88.0	66.4 *
			87.0	67.2
			90.0	67.2 *
GENERAL DYNAMICS, CA	LONG	1.5	90.8	81.6
			89.4	72.0
			89.4	70.5
		AVERAGE	89.1	70.8
		STANDARD DEVIATION	1.4	5.7

(*): INDICATES SHEAR TEAR OUT FAILURE

TABLE A9

BEARING RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING, WA	L TRANS	1.5	90.9	66.1
			90.0	66.4
			90.9	67.7
GENERAL DYNAMICS, CA	L TRANS	1.5	91.9	72.3
			92.5	71.7
			89.7	71.8
		AVERAGE	91.0	69.3
		STANDARD DEVIATION	1.1	2.9

TABLE A10

BEARING RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING. WA	LONG	2.0	111.0	79.8
			111.8	81.0
			110.3	81.5
GENERAL DYNAMICS. CA	LONG	2.0	113.9	90.6
			115.8	85.8
			113.5	86.4
		AVERAGE	112.7	84.2
		STANDARD DEVIATION	2.1	4.1

TABLE A11

BEARING RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING. WA	L TRANS	2.0	114.8	82.3
			112.6	82.3
			115.2	83.2
GENERAL DYNAMICS. CA	L TRANS	2.0	113.0	87.6
			114.2	95.1
			114.6	87.4
		AVERAGE	114.1	86.3
		STANDARD DEVIATION	1.0	4.9

TABLE A12

FRACTURE TOUGHNESS RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	KIC (KSI in^0.5)	Kq (KSI in^0.5)	COMMENT
GENERAL DYNAMICS, CA	L-T		37.0	(1,2,3)
			34.5	(1,2,3)
			35.4	(1,2,3)
NADC	L-T		42.6	(1)
			42.6	(1)
			40.6	(1)
			36.6	(1)
	AVERAGE		38.5	
	STANDARD DEVIATION		3.4	

(1): INVALID DUE TO Pmax/Pq > 1.10

(2): INVALID DUE TO a < 2.5(KQ/Fty)^2

(3): INVALID DUE TO B < 2.5(KQ/Fty)^2

TABLE A13

FRACTURE TOUGHNESS RESULTS FOR PECHINEY

2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	KIC (KSI in^0.5)	Kq (KSI in^0.5)	COMMENT
GENERAL DYNAMICS, CA	T-L		38.7	(1,2,3)
			36.5	(1,2,3)
			33.0	(1,2,3)
	AVERAGE		36.1	
	STANDARD DEVIATION		2.9	

(1): INVALID DUE TO Pmax/Pq > 1.10

(2): INVALID DUE TO a < 2.5(KQ/Fty)^2

(3): INVALID DUE TO B < 2.5(KQ/Fty)^2

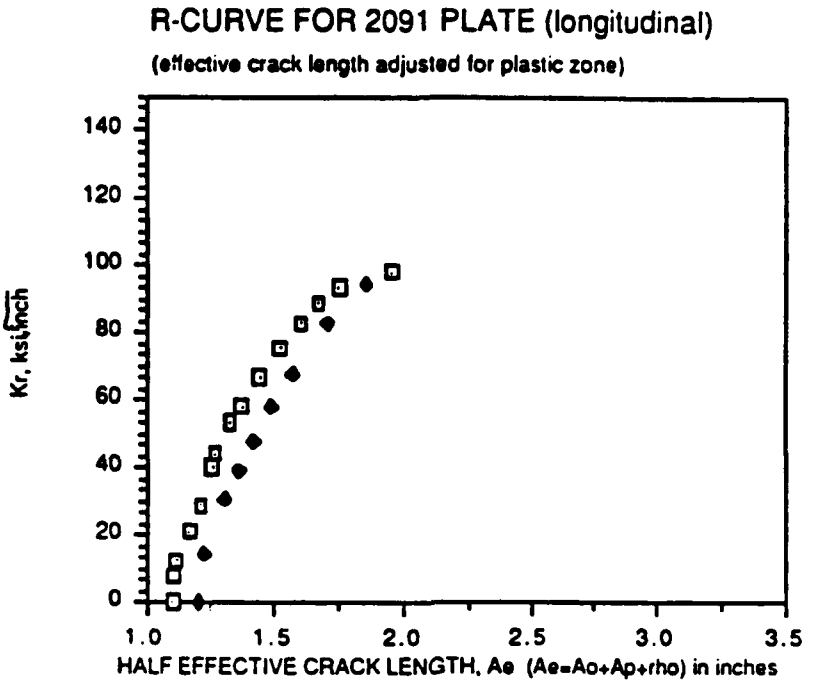


Figure A1 R-Curve Results for 2091-T351 0.42" Plate (longitudinal). Martin Marietta LA.

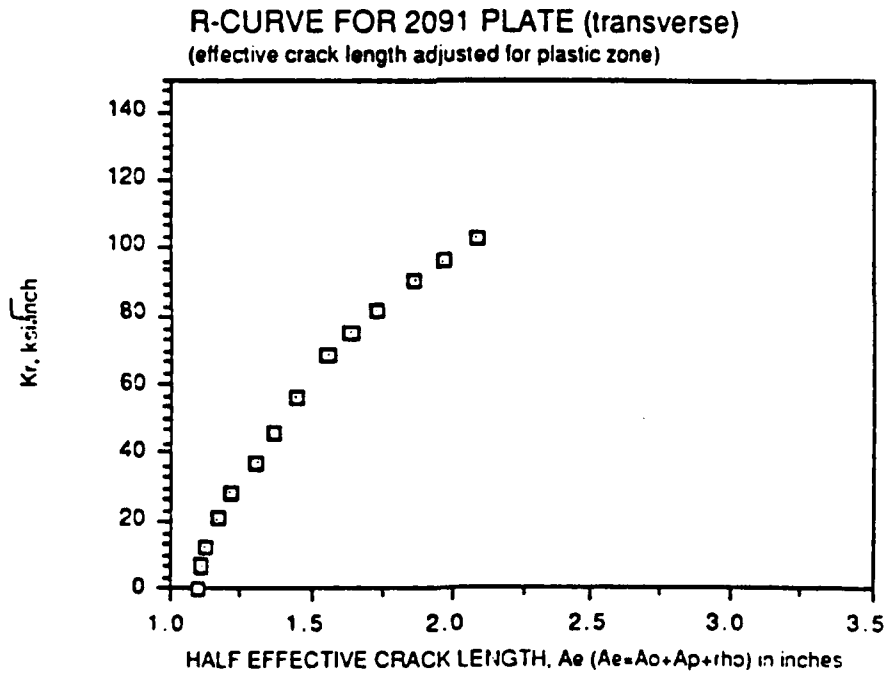


Figure A2 R-Curve Results for 2091-T351 0.42" Plate (transverse). Martin Marietta LA.

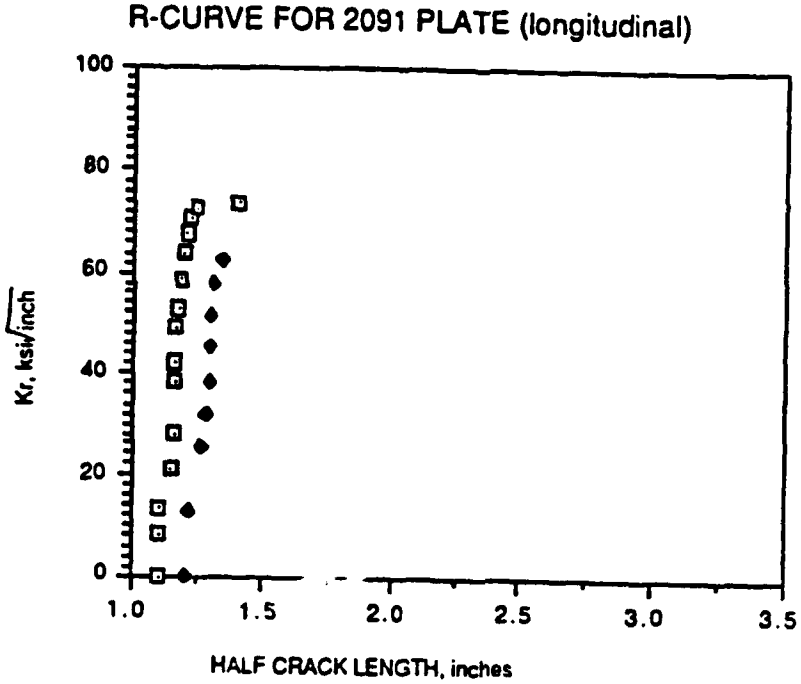


Figure A3 R-Curve Results for 2091-T351 0.42" Plate (longitudinal). Martin Marietta LA.

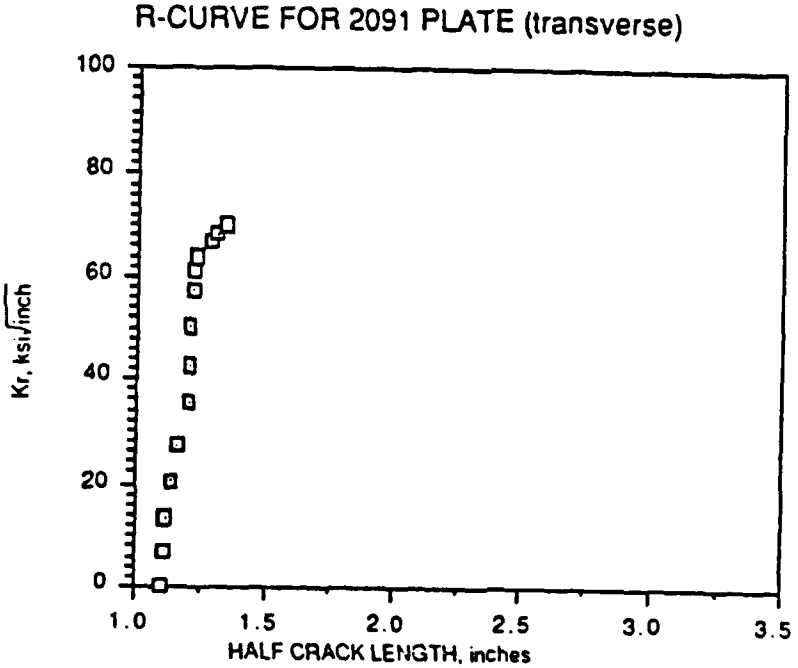


Figure A4 R-Curve Results for 2091-T351 0.42" Plate (transverse). Martin Marietta LA.

TABLE A14

DATA FOR SPECIMEN NO. 1, 2091

LONGITUDINAL PLATE

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi √inch	
			Not Adjusted	Adjusted for Plasticity
0.00	1.202	1.202	0.0	0.0
20.14	1.217	1.229	12.44	14.57
40.32	1.257	1.310	25.41	30.34
50.22	1.282	1.369	32.05	38.8
60.00	1.292	1.422	38.48	47.34
69.98	1.297	1.491	44.99	57.88
79.84	1.297	1.567	51.33	68.3
89.98	1.312	1.711	58.28	82.93
94.90	1.342	1.857	62.38	94.28

Thickness = .420 inch
Yield = 52.4 ksi
Specimen Width = 7.00 inch

TABLE A15

DATA FOR SPECIMEN NO. 2 2091

LONGITUDINAL PLATE

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi $\sqrt{inch}$	
			Not Adjusted	Adjusted for Plasticity
0.0	1.100	1.100	0.0	0.0
12.54	1.100	1.104	8.45	7.93
20.3	1.100	1.110	13.68	12.84
30.09	1.145	1.171	20.80	21.06
40.17	1.165	1.213	28.08	28.71
54.79	1.165	1.257	38.30	39.89
60.16	1.165	1.278	42.06	44.16
69.79	1.165	1.329	48.79	53.14
75.44	1.175	1.375	53.03	58.74
83.47	1.180	1.440	58.84	66.95
90.09	1.190	1.522	63.86	75.72
95.15	1.200	1.600	67.82	82.82
98.00	1.215	1.673	70.43	88.90
99.15	1.245	1.750	72.43	93.30
93.49	1.400	1.958	74.14	98.08

Thickness = .420 inch
Yield = 52.4 ksi
Specimen Width = 7.00 inch

TABLE A16

DATA FOR SPECIMEN NO. 3, 2091

TRANSVERSE PLATE

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi $\sqrt{inch}$	
			Not Adjusted	Adjusted for Plasticity
0.0	1.100	1.100	0.0	0.0
9.93	1.110	1.113	6.73	6.31
19.81	1.115	1.127	13.46	12.61
20.65	1.135	1.167	20.38	20.69
39.73	1.160	1.220	27.70	28.46
49.74	1.205	1.307	35.50	37.13
59.86	1.210	1.364	42.90	45.68
69.86	1.210	1.444	50.06	56.26
79.58	1.215	1.561	57.39	68.41
85.32	1.215	1.639	61.32	75.71
88.14	1.230	1.728	63.87	82.05
91.82	1.280	1.872	66.82	90.59
91.79	1.305	1.973	68.35	96.81
90.86	1.340	2.090	69.83	103.00

Thickness = .420 inch
Yield = 42.4 ksi
Specimen Width = 7.00 inch

TABLE A17

FATIGUE RESULTS WITH R=0.1 AND Kt=1.0 FOR

PECHINEY 2091-T351 PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
NADC	LONG	60.0	28,300
		60.0	29,600
		50.0	72,400
		50.0	87,000
		45.0	395,500
		45.0	779,200
		40.0	1.47E+06
		40.0	2.00E+06
		35.0	1.11E+07
		32.5	1.00E+08 *

(*): RUN OUT

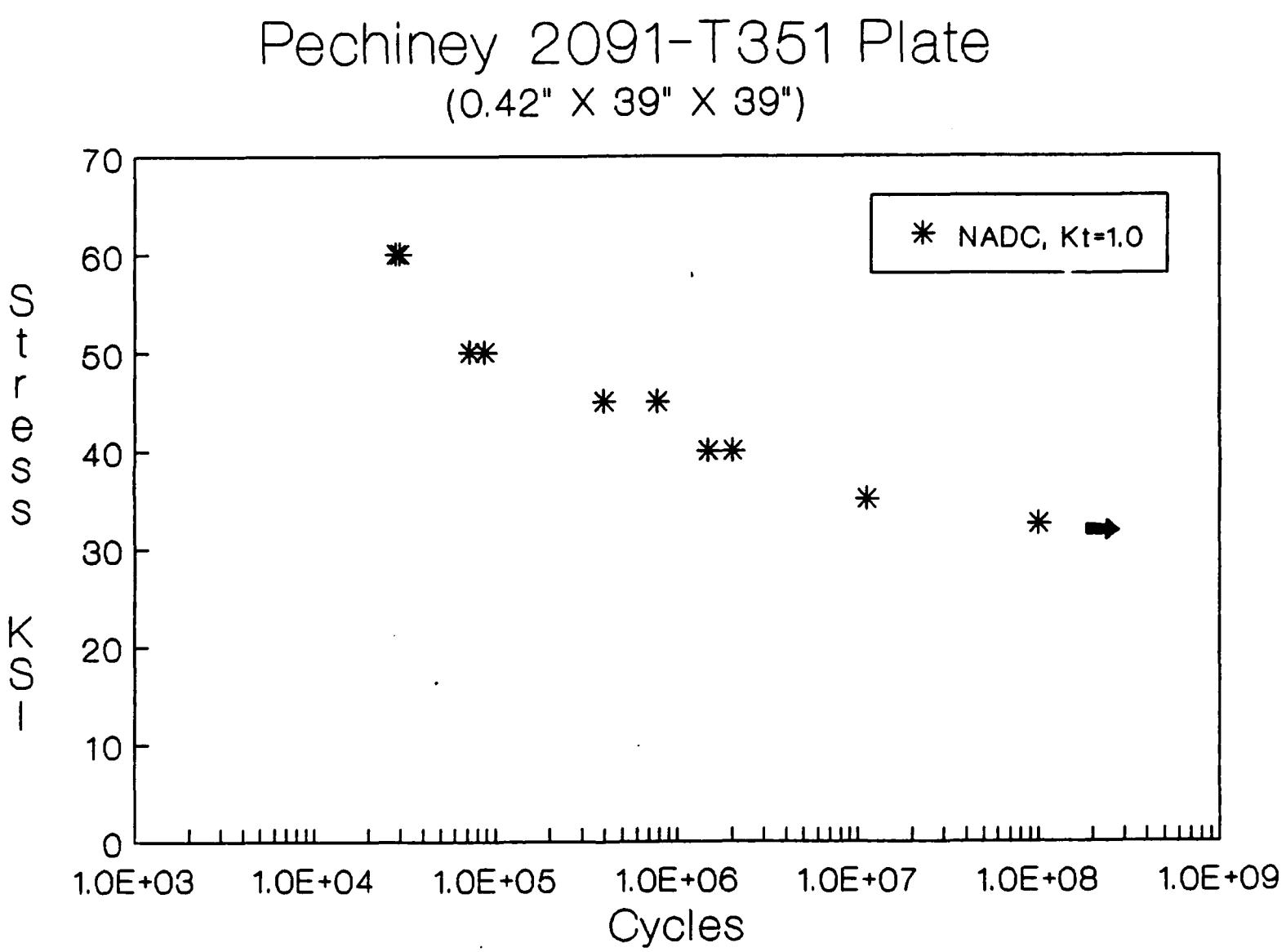


Figure A5 Fatigue Results for 2091-T351 0.42" Plate (R=0.1, Kt=1.0). NADC.

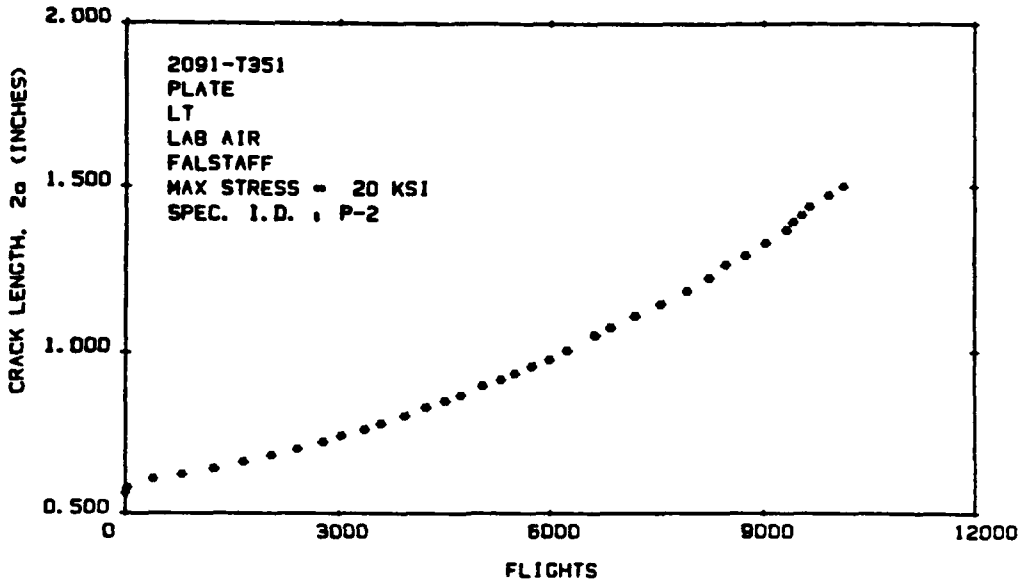


Figure A6 Crack Length Versus Flights for 2091-T351 Plate Under FALSTAFF Loading, Max Stress = 20 KSI.

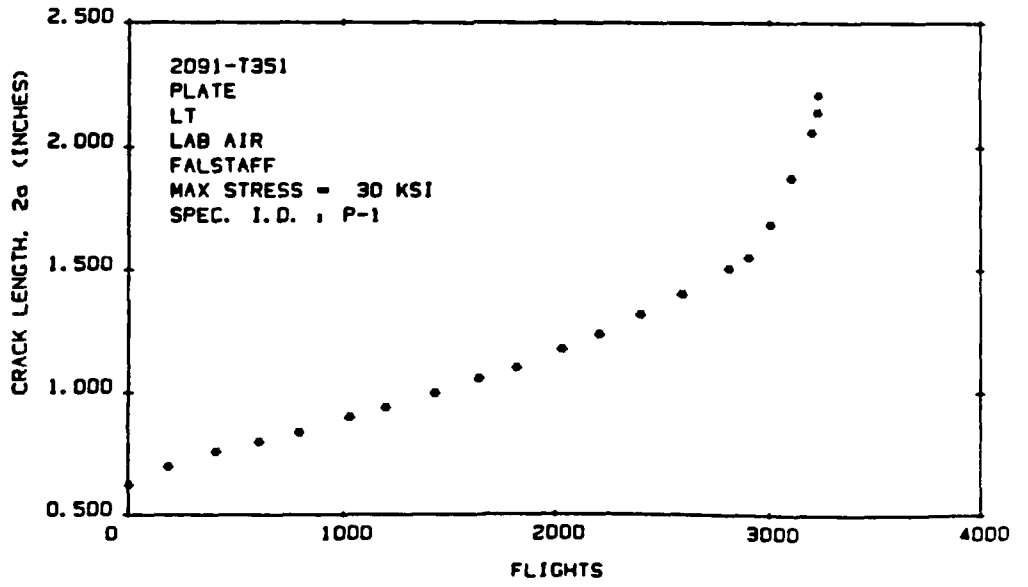


Figure A7 Crack Length Versus Flights for 2091-T351 Plate Under FALSTAFF Loading, Max Stress = 30 KSI.

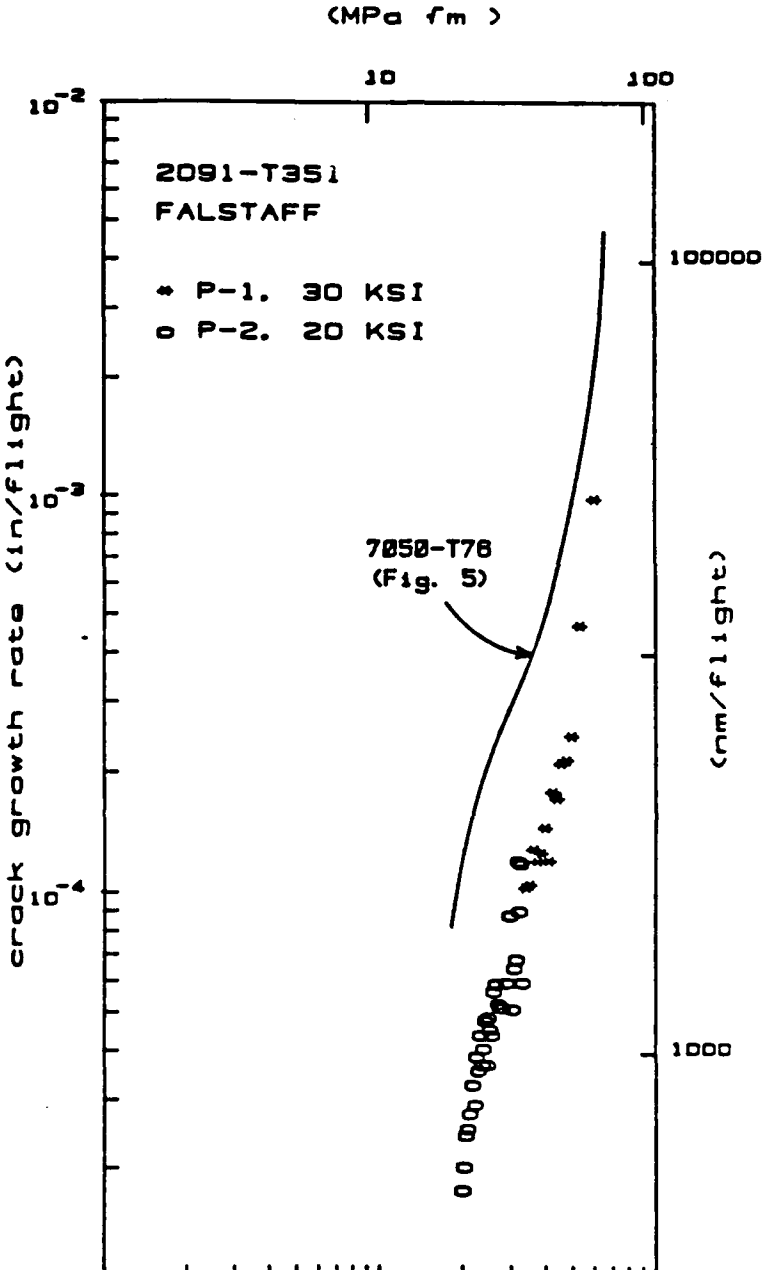


Figure A8 FALSTAFF Spectrum Results for 2091-T351 Reduced in Terms of Growth Rate and Maximum Spectrum Stress Intensity.

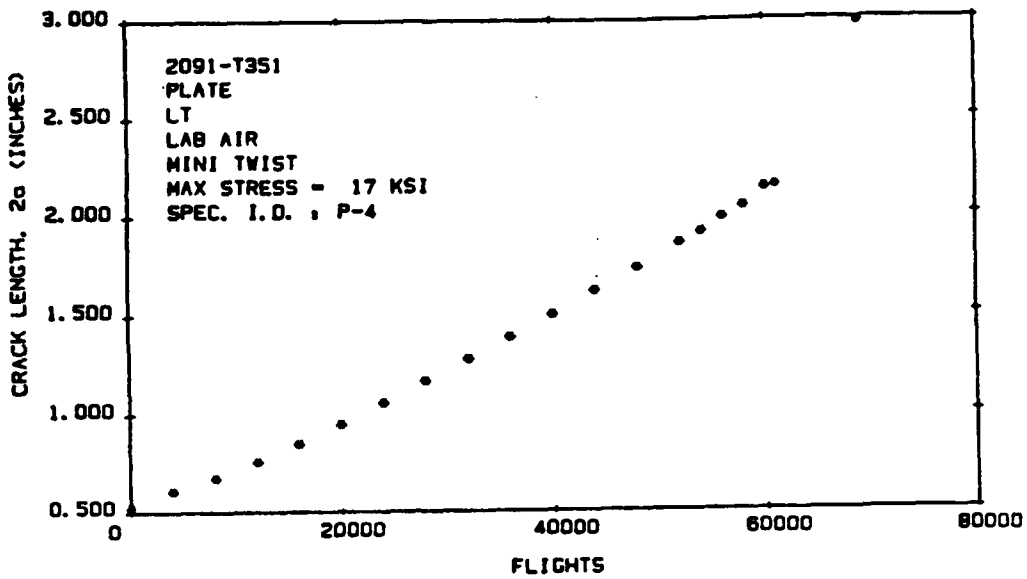


Figure A9 Crack Length Versus Flights for 2091-T351 Plate Under Mini-TWIST Loading, Max Stress = 17 KSI.

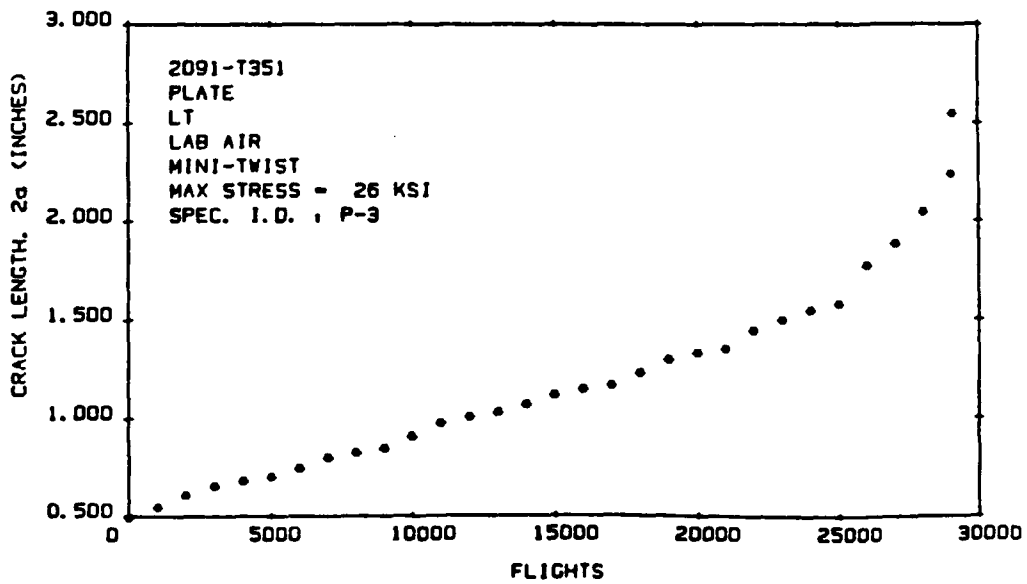


Figure A10 Crack Length Versus Flights for 2091-T351 Plate Under Mini-TWIST, Max Stress = 26 KSI.

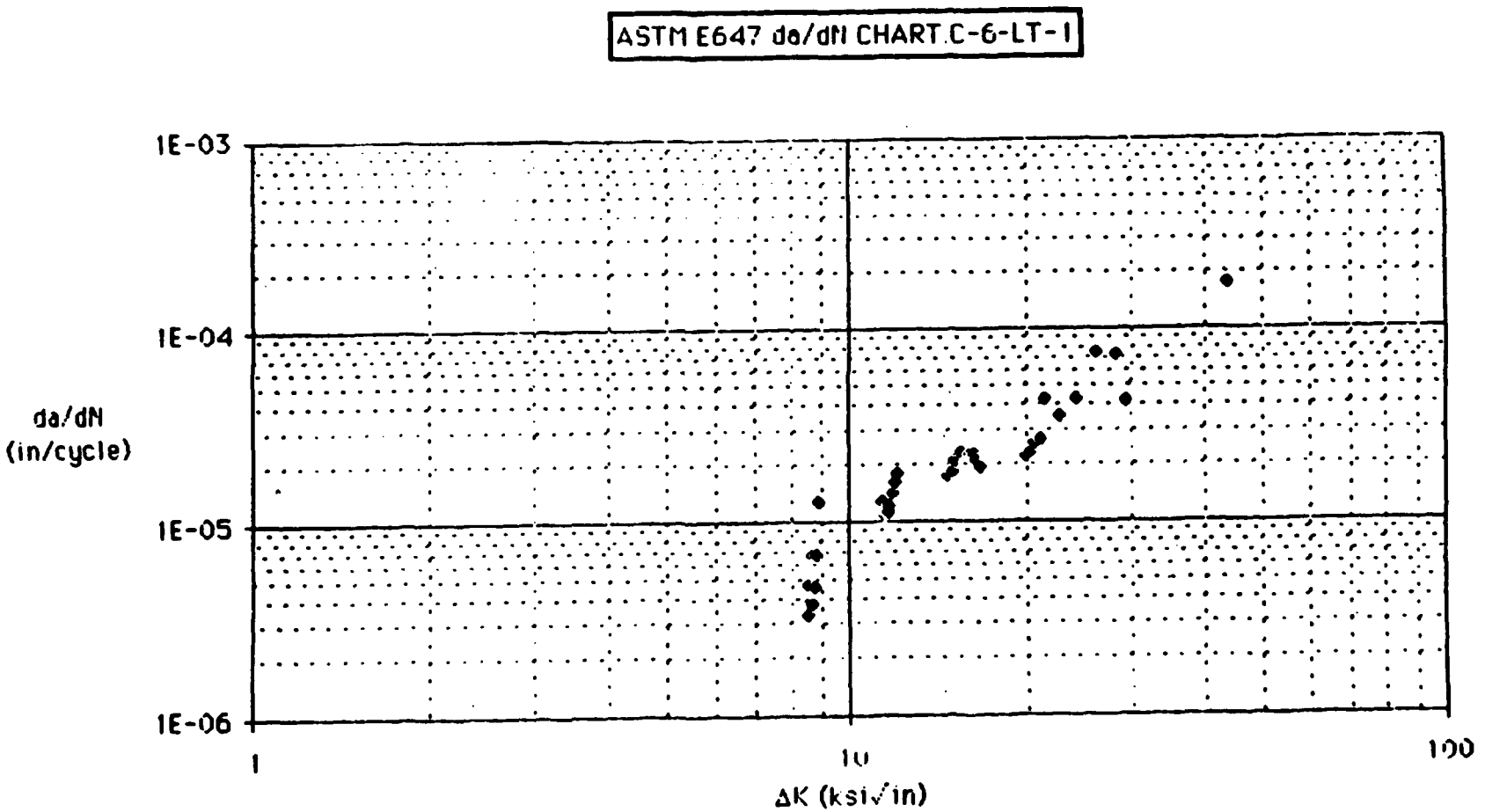


Figure A10A Fatigue Crack Growth Rate Data for 2091-T351 0.42" Plate (L-T Orientation). General Dynamics CA.

TABLE A17A

Fatigue Crack Growth Rate Data
Associated with Figure A10A

SEVEN-POINT INCREMENTAL POLYNOMIAL METHOD FOR DETERMINING da/dN

ASTM Method E647 Specimen No. C-6-L1-1 Specimen Type: CT

W = 2.007 in B = 0.423 in an = 0.665 in
Fty = 51.7 ksi R = 0.33

No	Cycles	Pmax	a (in)	a (rgr)	MCC	Kmax	Kmin	ΔK ksi√in	da/dN*1E6
1 '	0	1000	0.800			12096	3629	8467	
2 '	1000	1000	0.805			12171	3651	8520	4.7000
3 '	2000	1000	0.808			12224	3667	8557	3.3000
4	3000	1000	0.811	0.8117	0.9983	12279	3684	8595	3.8357
5	4000	1000	0.815	0.8155	0.9988	12344	3703	8641	3.7515
6	5000	1000	0.819	0.8193	0.9677	12408	3723	8686	6.7718
7	6000	1000	0.824	0.8215	0.948	12479	3744	8736	4.6049
8	7500	1000	0.829	0.8284	0.9677	12565	3769	8795	6.7718
9	9000	1000	0.835	0.8397	0.9814	12671	3801	8870	12.6917
10	10000	1250	0.854	0.8507	0.9814	16249	4875	11374	12.6917
11	10500	1250	0.859	0.8575	0.9561	16369	4911	11458	11.0374
12	11000	1250	0.865	0.8651	0.9736	16494	4948	11546	11.3000
13	11500	1250	0.871	0.8692	0.9736	16630	4989	11641	11.3000
14	12000	1250	0.871	0.8749	0.9777	16630	4989	11641	12.0560
15	12500	1250	0.883	0.8807	0.984	16906	5072	11834	14.0461
16	13000	1250	0.889	0.8884	0.9872	17047	5114	11933	16.0594
17	13460	1250	0.895	0.8975	0.9929	17190	5157	12033	17.5812
18	14000	1500	0.908	0.9066	0.9938	21007	6302	14705	17.2518
19	14500	1500	0.917	0.9159	0.9965	21276	6383	14893	18.0480
20	15000	1500	0.924	0.9240	0.9829	21488	6446	15042	20.8274
21	15500	1500	0.933	0.9339	0.9908	21767	6530	15237	22.2143
22	16000	1500	0.943	0.9468	0.9786	22083	6625	15458	22.8571
23	16500	1500	0.964	0.9605	0.9823	22771	6831	15940	22.4850
24	17000	1500	0.974	0.9712	0.9833	23111	6933	16178	22.1518
25	17500	1500	0.980	0.9807	0.9788	23319	6996	16323	20.7250
26	18250	1500	0.991	0.9931	0.9971	23709	7113	16596	19.2289
27	19000	1750	1.009	1.0082	0.9977	28431	8529	19902	21.5293
28	19500	1750	1.021	1.0199	0.9985	28966	8690	20276	23.0100
29	20000	1750	1.032	1.0317	0.9982	29470	8841	20629	25.5919
30	20500	1750	1.044	1.0441	0.9996	30038	9011	21026	26.8690
31	21000	1750	1.057	1.0583	0.9978	30674	9202	21472	42.7238
32	22000	1750	1.091	1.0886	0.9976	32450	9735	22715	35.5854
33	23000	1750	1.128	1.1280	0.9978	34591	10377	24214	42.7238
34	24000	1750	1.169	1.1705	0.9685	37261	11178	26083	75.9364
35 +	24500	1750	1.206			39988	11996	27992	74.0000
36 +	25000	1750	1.227			41691	12507	29184	42.0000 *
37 +	26000	1750	1.401			62237	18671	43566	174.0000 *

'*' - Indicates data violates specimen size requirements
'+' - Indicates no curve smoothing

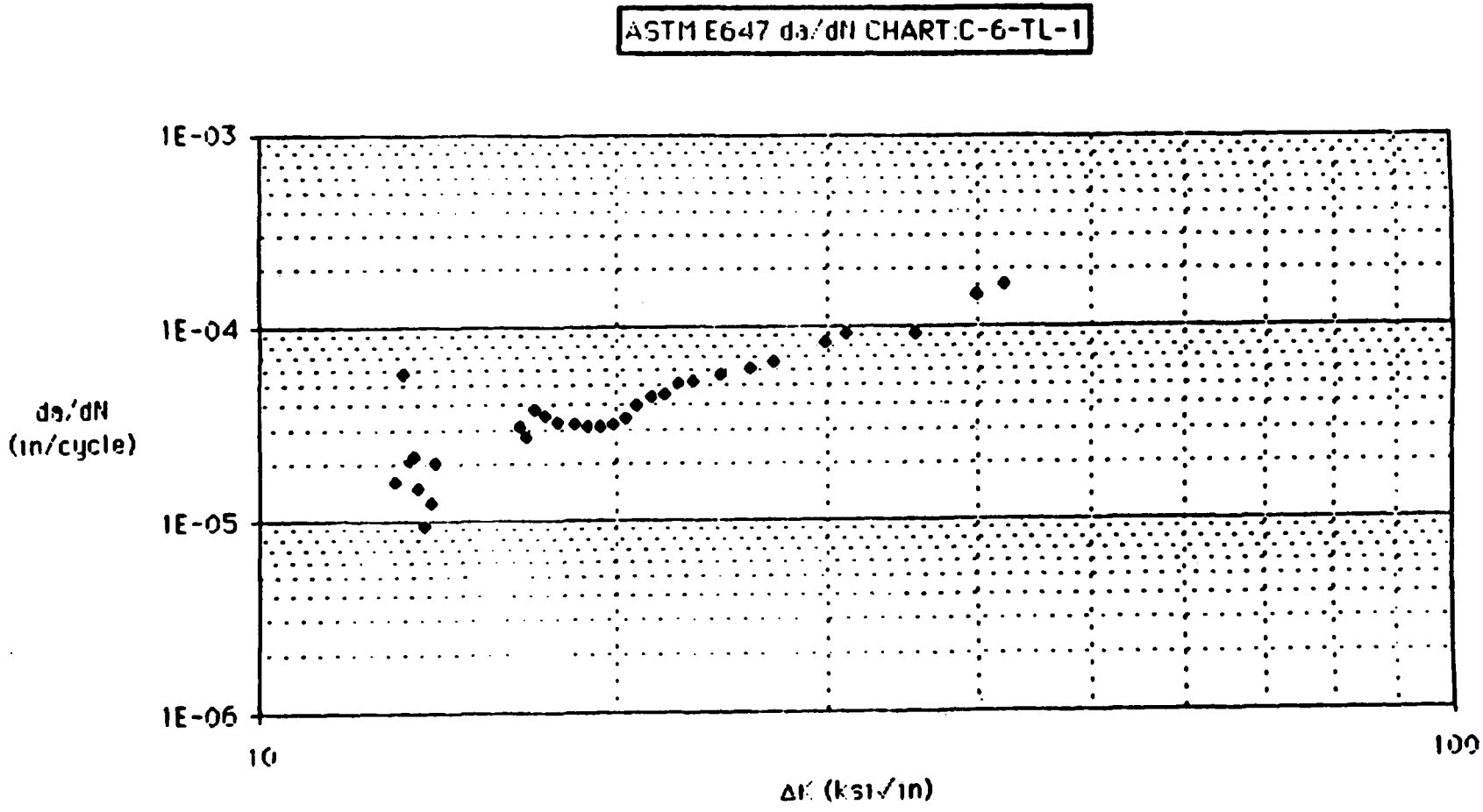


Figure A10b Fatigue Crack Growth Rate Data for 2091-T351 0.42" Plate (T-L Orientation). General Dynamics CA.

TABLE A17B

Fatigue Crack Growth Rate Data
Associated with Figure A10B

SEVEN-POINT INCREMENTAL POLYNOMIAL METHOD FOR DETERMINING da/dN

ASTM Method E647 Specimen No. C-6-TL-1 Specimen Type: CT

W = 2.003 in B = 0.422 in en = 0.665
Fty = 46.7 ksi R = 0.33

No.	Cycles	Pmax	a (in)	a (rgr)	MCC	Kmax	Kmin	ΔK ksi√in	da/dN* 1E6	
1 †	0	1500	0.800			18252	5476	12776		
2 †	810	1500	0.813			18569	5571	12998	16.0494	
3 †	1000	1500	0.824			18843	5653	13190	57.8947	
4	1400	1500	0.835	0.8351	0.9172	19122	5737	13386	20.4983	
5	1700	1500	0.839	0.8419	0.9080	19225	5768	13458	21.8550	
6	1500	1500	0.847	0.8373	0.9167	19434	5830	13604	14.8135	
7	3140	1500	0.855	0.8544	0.9467	19646	5894	13752	9.4950	
8	4000	1500	0.863	0.8620	0.9477	19862	5958	13903	12.3536	
9	4970	1500	0.871	0.8776	0.9385	20080	6024	14056	20.3209	
10	5200	1750	0.878	0.8815	0.9732	23654	7096	16558	31.2525	
11	5350	1750	0.887	0.8864	0.9610	23951	7185	16766	27.4423	
12	5600	1750	0.898	0.8963	0.9948	24321	7296	17025	38.3779	
13	6020	1750	0.914	0.9111	0.9951	24876	7463	17413	35.2983	
14	6630	1750	0.930	0.9323	0.9976	25451	7635	17816	32.3402	
15	7360	1750	0.954	0.9537	0.9987	26354	7906	18448	31.8564	
16	7620	1750	0.969	0.9684	0.9984	26945	8083	18861	31.3680	
17	8320	1750	0.985	0.9851	1.0000	27599	8280	19320	31.3809	
18	8830	1750	1.001	1.0001	0.9976	28281	8484	19796	31.4888	
19	9590	1750	1.017	1.0166	0.9946	28990	8697	20293	34.6364	
20	9920	1750	1.032	1.0351	0.9966	29683	8905	20778	39.9120	
21	10250	1750	1.048	1.0482	0.9979	30452	9136	21317	43.7701	
22	10540	1750	1.064	1.0622	0.9974	31257	9377	21880	45.8995	
23	10900	1750	1.080	1.0798	0.9985	32098	9629	22468	51.2355	
24	11190	1750	1.095	1.0946	0.9990	32922	9877	23045	52.5461	
25	11820	1750	1.127	1.1296	0.9993	34805	10442	24364	57.1945	
26	12260	1750	1.158	1.1557	0.9994	36813	11044	25769	61.4515	
27	12670	1750	1.182	1.1802	0.9986	38508	11552	26955	66.9568	*
28	13450	1750	1.233	1.2347	0.9963	42585	12775	29809	84.3019	*
29	13690	1750	1.253	1.2524	0.9981	44388	13317	31072	92.9751	*
30 †	14320	1750	1.312			50538	15161	35377	93.6508	*
31 †	14670	1750	1.363			57100	17130	39970	145.7143	*
32 †	14790	1750	1.383			60069	18021	42048	166.6667	*

'*' - Indicates data violates specimen size requirements
'†' - Indicates no curve smoothing

PECHINEY

2091-T8X PLATE

TABLE A18

TENSILE RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	LONG	71.4	60.6	10.0	16.0	11.5
			71.5	59.9	12.0	16.0	11.4
			71.8	61.1	11.0	16.0	11.4
			71.5	60.4	10.0		11.4
			72.0	60.4	11.0		11.4
			72.0	60.6	9.0		11.5
GRUMMAN	RT	LONG	68.7	58.2	6.0	6.2	11.8
			70.0	58.2	8.5	9.2	11.9
			67.6	58.4	6.5	6.8	11.1
GENERAL DYNAMICS, TX	RT	LONG	72.8	60.6	8.0		
			72.5	60.8	7.3		
		AVERAGE	71.1	59.9	9.0	11.7	11.5
		STANDARD DEVIATION	1.6	1.1	2.0	4.8	0.2

TABLE A19

TENSILE RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	L TRANS	72.4	54.8	12.0	17.4	11.5
			72.5	55.0	12.0	17.8	11.6
			72.4	55.0	12.0	18.5	11.4
			69.2	51.1	15.0		11.4
			69.5	51.2	17.0		11.2
			69.1	50.9	16.0		11.8
GRUMMAN	RT	L TRANS	69.5	53.0	13.5	22.3	11.5
			69.0	51.1	13.0	16.8	13.0
			69.1	53.0	13.5	17.6	13.4
GENERAL DYNAMICS, TX	RT	L TRANS	71.8	55.9	11.0		
			72.0	55.9	11.0		
		AVERAGE	70.6	53.4	13.3	18.4	11.9
	STANDARD DEVIATION		1.6	2.0	2.0	2.0	0.8

TABLE A20

TENSILE RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T8X PLATE (0.42' X 39' X 39')

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
GRUMMAN	RT	45	63.9	45.8	21.0	29.7	11.2
			62.5	45.7	21.5	27.2	11.1
			62.9	45.3	20.5	28.7	11.1
		AVERAGE	63.1	45.6	21.0	28.5	11.1
	STANDARD DEVIATION		0.7	0.3	0.5	1.3	0.1

TABLE A21

TENSILE RESULTS AT t/10 LOCATION FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	LONG	71.6	60.0	10.0		11.3
			71.2	59.9	10.0		11.5
			71.4	60.4	10.0		11.1
		AVERAGE	71.4	60.1	10.0		11.3
		STANDARD DEVIATION	0.2	0.3	0.0		0.2

TABLE A22

TENSILE RESULTS AT t/10 LOCATION FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
NORTHROP	RT	L TRANS	69.6	51.2	18.0		11.1
			69.3	51.1	16.0		11.6
			69.7	51.4	15.0		11.4
		AVERAGE	69.5	51.2	16.3		11.4
		STANDARD DEVIATION	0.2	0.2	1.5		0.3

TABLE A23

TENSILE RESULTS AT t/2 LOCATION WITH 100 HOURS EXPOSURE FOR

PECHINEY 2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMP (DEGREES F)	EXPOSURE TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)
NORTHROP	RT	300	LONG	77.7	65.8	9.0	12.3
				77.7	65.9	9.0	11.6
		350	LONG	75.8	70.6	7.0	15.9
				76.1	70.7	7.0	18.9
		375	LONG	71.3	64.7	7.0	18.5
				71.6	64.8	7.0	18.1
		400	LONG	66.9	58.1	7.0	18.5
				66.7	58.0	7.0	18.1

TABLE A24

COMPRESSION RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
NORTHROP	RT	LONG	48.6	
			48.3	
			48.6	
GRUMMAN	RT	LONG	48.1	11.9
			50.5	11.5
			48.4	11.1
GENERAL DYNAMICS, TX	RT	LONG	48.6	
			49.2	
		AVERAGE	48.8	11.5
		STANDARD DEVIATION	0.8	0.4

TABLE A25

COMPRESSION RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
NORTHROP	RT	L TRANS	57.6	
			57.4	
			57.5	
GRUMMAN	RT	L TRANS	58.3	11.9
			58.2	11.2
			58.9	11.6
GENERAL DYNAMICS. TX	RT	L TRANS	57.5	
			60.9	
		AVERAGE	58.3	11.5
		STANDARD DEVIATION	1.2	0.3

TABLE A26

COMPRESSION RESULTS AT t/2 LOCATION FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
GRUMMAN	RT	45	49.5	11.3
			48.6	11.4
			49.6	10.8
		AVERAGE	49.2	11.2
		STANDARD DEVIATION	0.6	0.3

TABLE A27

RIVET SHEAR RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	L-S	35.9
		35.9
		35.9
GRUMMAN	L-S	36.4
		36.0
		37.8
	AVERAGE	36.6
	STANDARD DEVIATION	1.0

TABLE A28

RIVET SHEAR RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	T-S	33.5
		33.5
		33.9
GRUMMAN	T-S	34.6
		35.9
		37.2
	AVERAGE	34.8
	STANDARD DEVIATION	1.8

TABLE A29

SLOTTED SHEAR RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
GENERAL DYNAMICS. TX	LONG	41.3
		40.9
	AVERAGE	41.1
	STANDARD DEVIATION	0.3

TABLE A30

SLOTTED SHEAR RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
GENERAL DYNAMICS. TX	L TRANS	42.6
		43.4
	AVERAGE	43.0
	STANDARD DEVIATION	0.6

TABLE A31

BEARING RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	LONG	1.5	93.0	73.0
			89.6	71.8
			92.6	73.7
GRUMMAN	LONG	1.5	92.9	71.9
			93.8	73.0
			93.4	72.1
GENERAL DYNAMICS, TX	LONG	1.5	117.0	93.0
			112.0	91.4
		AVERAGE	98.0	77.5
		STANDARD DEVIATION	10.3	9.1

TABLE A32

BEARING RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	L TRANS	1.5	99.3	75.5
			98.9	76.0
			97.9	74.2
GRUMMAN	L TRANS	1.5	94.9	73.0
			91.9	70.1
			92.8	71.0
GENERAL DYNAMICS, TX	L TRANS	1.5	97.0	79.1
			97.8	80.5
		AVERAGE	96.3	74.9
		STANDARD DEVIATION	2.8	3.6

TABLE A33

BEARING RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	LONG	2.0	119.4	86.8
			118.9	87.8
			118.6	86.4
GRUMMAN	LONG	2.0	113.0	85.6
			115.5	86.9
			114.2	87.1
GENERAL DYNAMICS, TX	LONG	2.0	123.0	91.3
			122.0	94.0
		AVERAGE	118.1	88.2
		STANDARD DEVIATION	3.6	2.9

TABLE A34

BEARING RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	L TRANS	2.0	123.9	90.7
			124.2	94.2
			124.1	92.1
GRUMMAN	L TRANS	2.0	115.6	88.2
			117.5	89.5
			114.9	88.9
GENERAL DYNAMICS, TX	L TRANS	2.0	99.3	82.7
			103.0	85.3
		AVERAGE	115.3	89.0
		STANDARD DEVIATION	9.6	3.7

TABLE A35

FRACTURE TOUGHNESS RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	KIC (KSI in^0.5)	Kq (KSI in^0.5)	COMMENT
NORTHROP	L-T	27.0		VALID
		28.0		VALID
GRUMMAN	L-T		40.1	INVALID(1)
			43.2	INVALID(1,2)
			39.5	INVALID(1,2)
GENERAL DYNAMICS, TX	L-T		29.9	INVALID(2,3,4)
			29.0	INVALID(2,3,4)
	AVERAGE	27.5	36.3	
	STANDARD DEVIATION	0.7	6.5	

(1): $2.5(Kq)^2/(YS)^2 > B$
(2): $Pmax/Pq > 1.10$
(3): INSUFFICIENT THICKNESS
(4): CRACK CURVATURE > 5%

TABLE A36

FRACTURE TOUGHNESS RESULTS FOR PECHINEY

2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	KIC (KSI in^0.5)	Kq (KSI in^0.5)	COMMENT
NORTHROP	T-L	29.8		VALID
		28.5		VALID
GRUMMAN	T-L		40.5	INVALID(1)
			43.2	INVALID(1,2)
			38.2	INVALID(1,2)
GENERAL DYNAMICS. TX	T-L		27.1	INVALID(2,3)
			27.0	INVALID(2,3,4)
	AVERAGE	29.2	35.2	
	STANDARD DEVIATION	0.9	7.6	

(1): $2.5(Kq)^2/(YS)^2 > B$
(2): $Pmax/Pq > 1.10$
(3): INSUFFICIENT THICKNESS
(4): CRACK CURVATURE > 5%

TABLE A37

General Dynamics, Texas

Pechiney 2091-T8X Plate

(0.42" X 39" X 39")

Results of R-Curve Tests

	K_{R25}, ksi-in$^{\frac{1}{2}}$
L-T	48.3
L-T	50.2
T-L	43.2
T-L	43.2

TABLE A38

SMOOTH FATIGUE RESULTS WITH R=0.1 AND Kt=1.0 FOR

PECHINEY 2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
NORTHROP	LONG	60.0	31,299
		50.0	84,556
		45.0	135,397
		45.0	140,237
		40.0	242,930
		37.5	1,386,890
		37.5	934,697
		35.0	2,000,000 *

(*): INDICATES RUN-OUT TEST

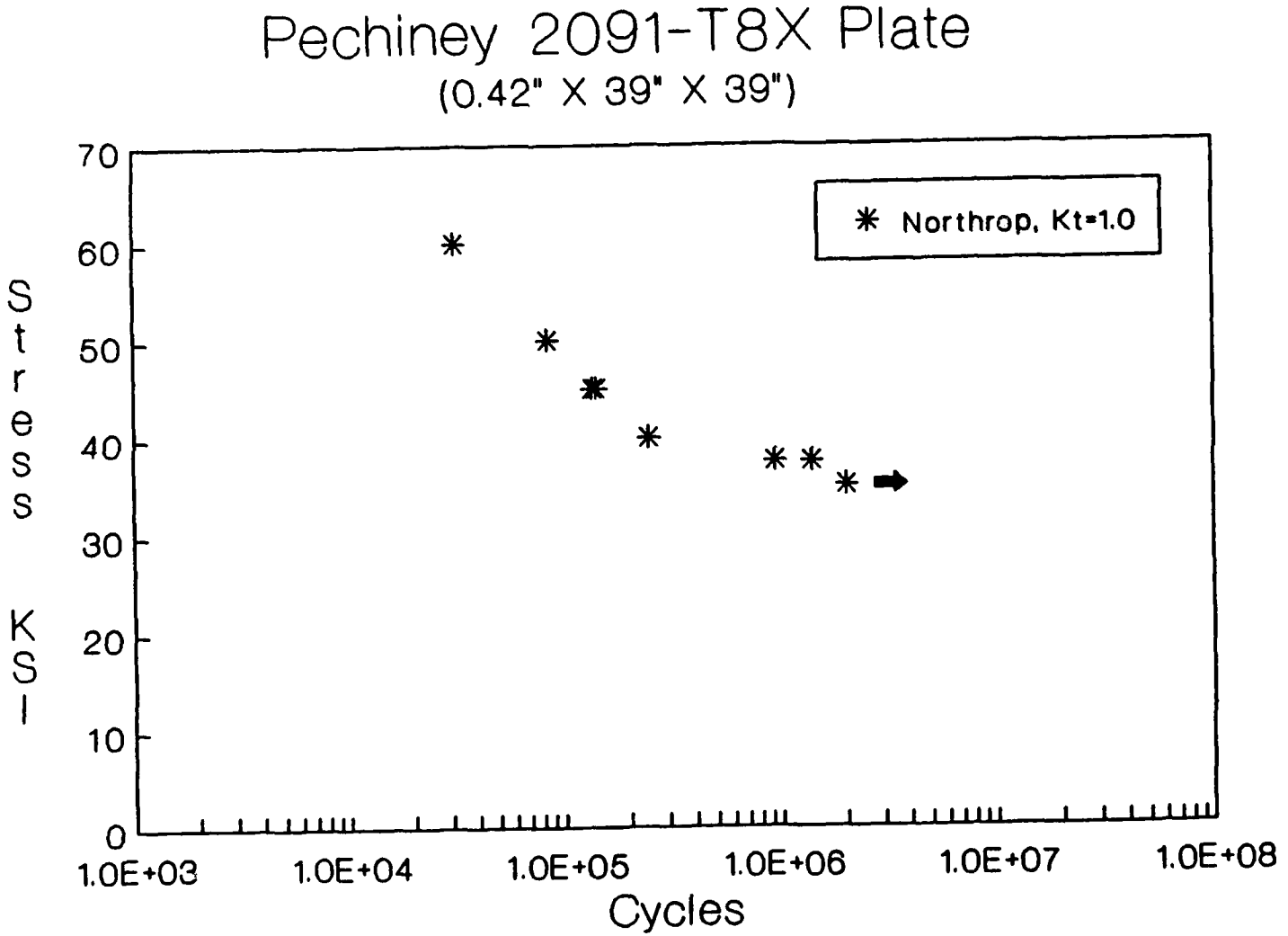


Figure A11 Fatique Results for 2091-T8X 0.42" Plate (R=0.1, Kt=1.0). Northrop.

TABLE A39

NOTCHED FATIGUE RESULTS WITH R=0.1 AND Kt=3.0 FOR

PECHINEY 2091-T8X PLATE (0.42" X 39" X 39")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
NORTHROP	LONG	45.0	13,635
		40.0	26,179
		35.0	48,930
		30.0	216,536
		27.5	257,234
		27.5	193,418
		25.0	474,737 *
		23.0	940,075

(*): INDICATES SLANT FAILURE

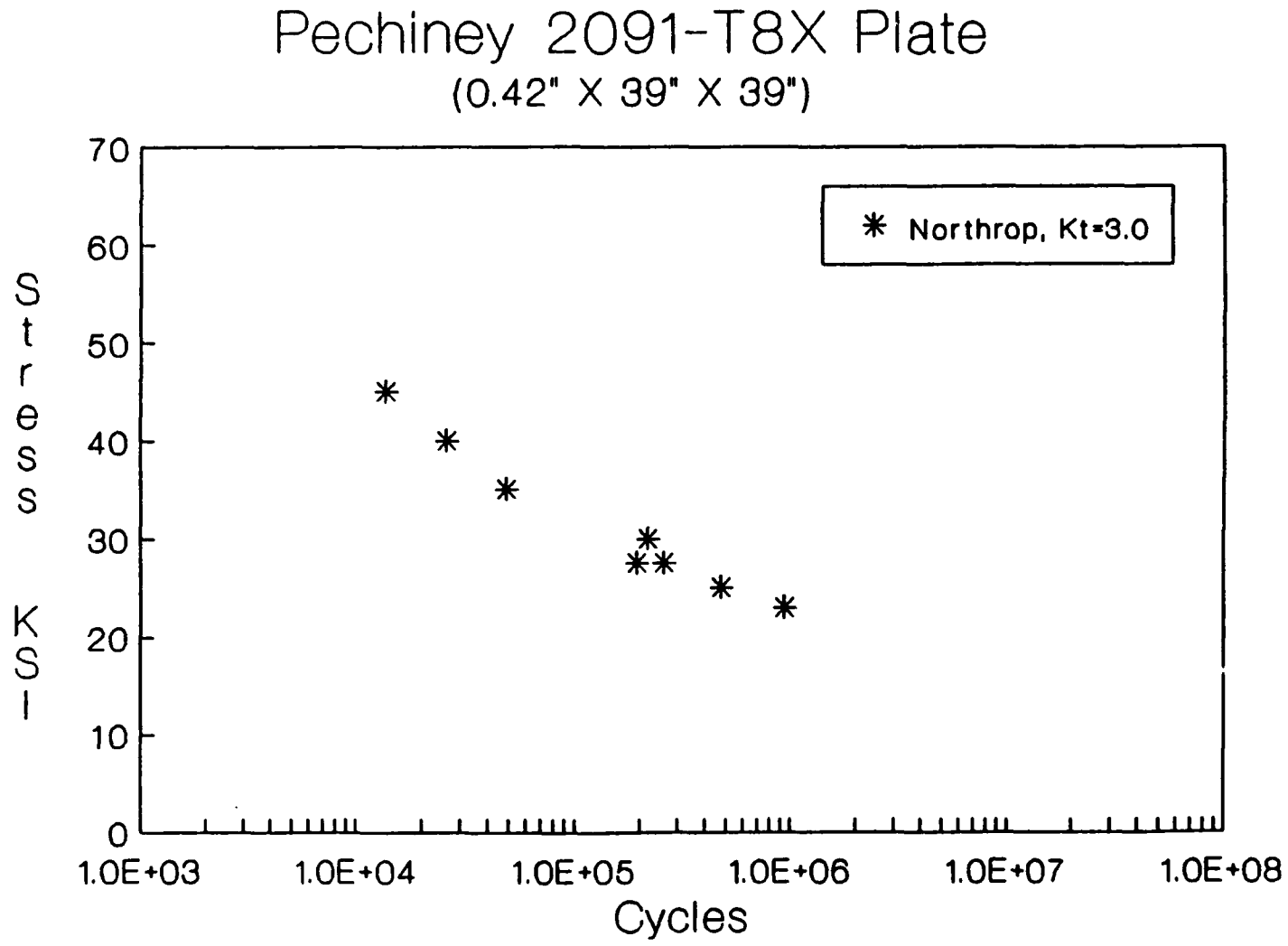


Figure A12 Fatigue Results for 2091-T8X 0.42" Plate (R=0.1, Kt=3.0). Northrop.

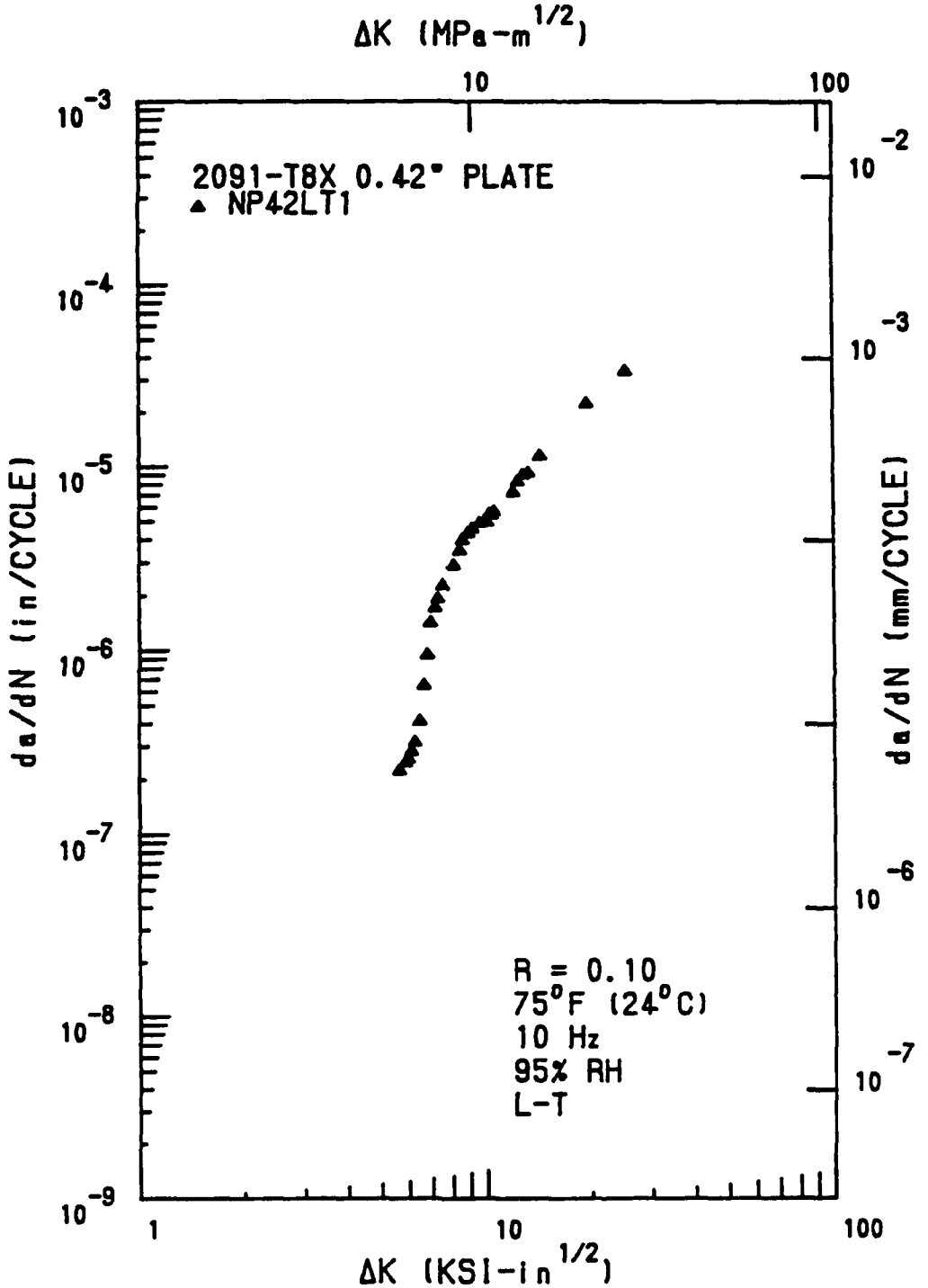


Figure A13 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.42" Plate (L-T Orientation). Northrop.

TABLE A40

Fatigue Crack Growth Rate Data Associated with Figure A13

Seven Point Incremental Polynomial Method per ASTM E647

02-10-1989

Specimen Number: NP42LT1 Specimen Type: CT

B= 0.2530 in W= 3.0090 in An= 0.0000

Pmax= 0.550 kips Pmin= 0.055 kips

R= 0.10 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 95% RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.6860				
2	110.00	0.7075				
3	260.00	0.7385				
4	370.00	0.7610	0.7618	0.999873	5.60	.2206E-06
5	577.00	0.8110	0.8100	0.999899	5.85	.2428E-06
6	657.00	0.8295	0.8294	0.999733	5.95	.2558E-06
7	762.00	0.8560	0.8568	0.998942	6.09	.2802E-06
8	860.00	0.8830	0.8830	0.998830	6.23	.3150E-06
9	956.00	0.9130	0.9147	0.990732 *	6.41	.4086E-06
10	1036.00	0.9435	0.9511	0.972252	6.61	.6409E-06
11	1071.00	0.9625	0.9735	0.972984	6.74	.9437E-06
12	1101.00	0.9925	1.0009	0.991457	6.90	.1406E-05
13	1124.00	1.0320	1.0330	0.997454	7.09	.1691E-05
14	1136.00	1.0580	1.0554	0.998488	7.22	.1901E-05
15	1156.00	1.1005	1.0971	0.997670	7.49	.2241E-05
16	1190.00	1.1730	1.1791	0.997498	8.04	.2885E-05
17	1205.00	1.2205	1.2239	0.998194	8.36	.3456E-05
18	1212.00	1.2500	1.2473	0.999542	8.53	.3926E-05
19	1222.00	1.2860	1.2888	0.999041	8.86	.4289E-05
20	1229.00	1.3190	1.3206	0.998878	9.12	.4543E-05
21	1240.00	1.3775	1.3725	0.998727	9.57	.4861E-05
22	1250.00	1.4225	1.4240	0.999389	10.05	.4939E-05
23	1255.00	1.4370	1.4383	0.998825	10.20	.5449E-05
24	1256.00	1.4535	1.4533	0.999989	10.35	.5377E-05
25	1259.00	1.4700	1.4697	0.999983	10.52	.5618E-05
26	1278.00	1.5910	1.5909	0.999978	11.93	.7186E-05
27	1282.00	1.6195	1.6188	0.999055	12.31	.8224E-05
28	1286.00	1.6510	1.6524	0.999458	12.78	.8977E-05
29	1290.00	1.6835	1.6822	0.996456	13.23	.9208E-05
30	1297.00	1.7625	1.7436	0.991133	14.24	.1144E-04
31	1312.00	1.9435	1.9699	0.986239	19.42	.2214E-04
32	1318.00	2.0630	2.1283	0.977265	25.28	.3349E-04
33	1320.00	2.1750				
34	1321.00	2.2400				
35	1322.00	2.3240				

* - DATA VIOLATES SIZE REQUIREMENTS

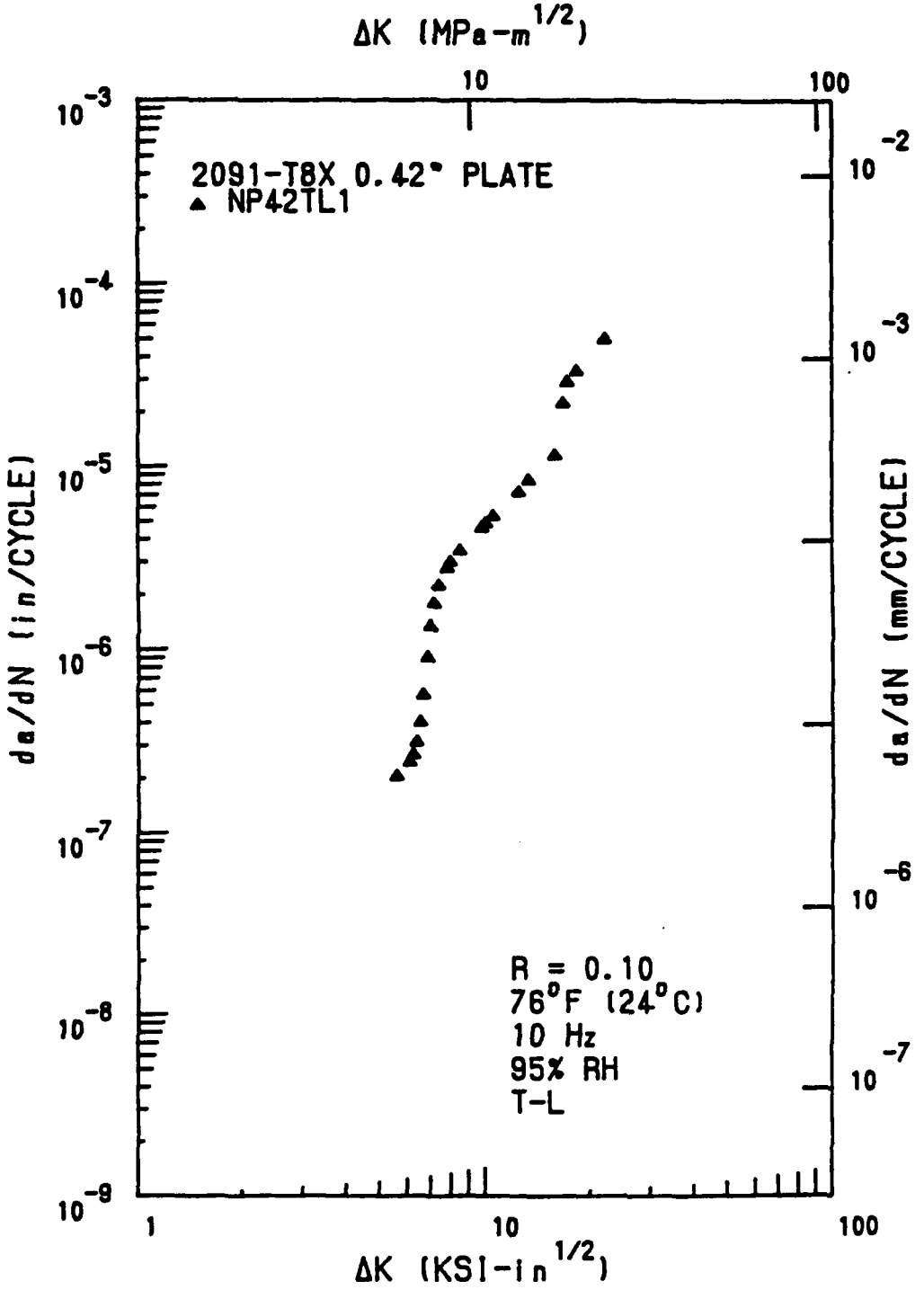


Figure A14 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.42" Plate (T-L Orientation). Northrop.

TABLE A41

Fatigue Crack Growth Rate Data Associated with Figure A14

Seven Point Incremental Polynomial Method per ASTM E647

02-10-1989

Specimen Number: NP42TL1 Specimen Type: CT

B= 0.2530 in W= 3.0090 in An= 0.0000

Pmax= 0.500 kips Pmin= 0.050 kips

R= 0.10 Frequency= 10.00 hz.

Test Temperature= 76 F Environment= 95% RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.6280				
2	1280.00	0.8080				
3	1450.00	0.8370				
4	1585.00	0.8625	0.8647	0.999893	5.58	.2042E-06
5	2055.00	0.9690	0.9673	0.999906	6.09	.2428E-06
6	2170.00	0.9955	0.9962	0.999109	6.24	.2669E-06
7	2265.00	1.0200	1.0233	0.993956	6.39	.3128E-06
8	2355.00	1.0440	1.0484	0.993095	6.53	.3997E-06
9	2425.00	1.0725	1.0774	0.991288	6.69	.5594E-06
10	2475.00	1.1035	1.1088	0.978290	6.87	.8988E-06
11	2495.00	1.1190	1.1240	0.980810	6.96	.1326E-05
12	2520.00	1.1465	1.1549	0.995230	7.15	.1767E-05
13	2540.00	1.1910	1.1900	0.999308	7.37	.2212E-05
14	2565.00	1.2560	1.2547	0.999315	7.81	.2765E-05
15	2572.00	1.2758	1.2764	0.999977	7.96	.2981E-05
16	2595.00	1.3505	1.3488	0.999622	8.51	.3448E-05
17	2634.00	1.4960	1.4986	0.999617	9.85	.4574E-05
18	2639.50	1.5210	1.5235	0.999455	10.10	.4851E-05
19	2649.00	1.5715	1.5682	0.999400	10.59	.5307E-05
20	2675.00	1.7145	1.7174	0.997564	12.54	.7175E-05
21	2682.20	1.7685	1.7703	0.995364	13.38	.8341E-05
22	2695.50	1.8725	1.9005	0.987147	15.94	.1148E-04
23	2698.25	1.9220	1.9375	0.969562	16.82	.2213E-04
24	2699.35	1.9475	1.9546	0.995890	17.25	.2907E-04
25	2701.00	1.9935	1.9956	0.999860	18.38	.3332E-04
26	2704.00	2.1135	2.1099	0.996875	22.24	.4978E-04
27	2705.00	2.1605				
28	2707.00	2.2700				
29	2708.00	2.3720				

* - DATA VIOLATES SIZE REQUIREMENTS

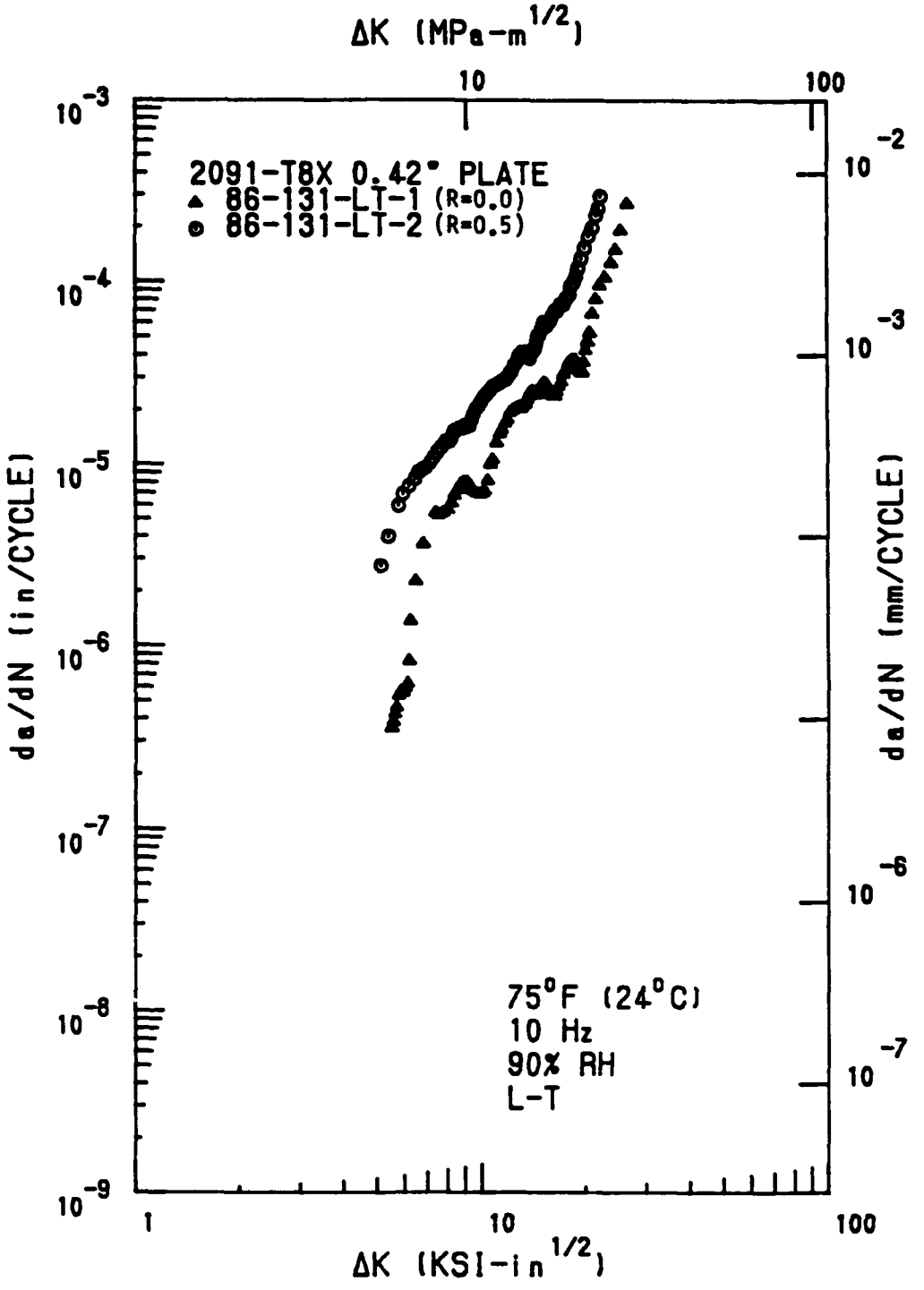


Figure A15 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.42" Plate (L-T Orientation). Grumman.

TABLE A42

Fatigue Crack Growth Rate Data Associated with Figure A15

Seven Point Incremental Polynomial Method per ASTM E647

1-07-1988

Specimen Number: 1 (B4-131-LT-1) Specimen Type: CCT

B= 0.2510 in W= 3.7570 in An= 0.0000

Pmax= 6.258 kips Pmin= 0.000 kips

R= 0.00 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	Amess*2	Areg	MCC	Delta K	da/dN
1	0.00	0.3750				
2	100.00	0.4130				
3	125.00	0.4230				
4	150.00	0.4280	0.4293	0.993070	5.49	.3509E-06
5	175.00	0.4350	0.4359	0.994133	5.54	.3814E-06
6	200.00	0.4450	0.4459	0.995104	5.60	.4186E-06
7	225.00	0.4580	0.4584	0.993770	5.68	.4557E-06
8	250.00	0.4730	0.4698	0.989179	5.76	.5286E-06
9	275.00	0.4830	0.4838	0.989264	5.84	.5557E-06
10	300.00	0.4930	0.4985	0.985594	5.94	.5500E-06
11	325.00	0.5180	0.5119	0.985675	6.02	.5800E-06
12	350.00	0.5280	0.5274	0.988314	6.11	.6143E-06
13	375.00	0.5380	0.5389	0.985856	6.18	.6171E-06
14	400.00	0.5600	0.5500	0.963793	6.25	.1353E-05
15	425.00	0.5750	0.5848	0.982328	6.46	.2233E-05
16	450.00	0.6350	0.6466	0.993047	6.81	.3580E-05
17	475.00	0.7500	0.7500	0.997940	7.39	.5334E-05
18	480.00	0.7850	0.7782	0.996031	7.54	.5181E-05
19	487.00	0.8250	0.8194	0.998323	7.76	.5355E-05
20	495.00	0.8630	0.8642	0.997329	7.99	.5590E-05
21	503.00	0.9030	0.9068	0.998029	8.22	.6053E-05
22	508.00	0.9380	0.9359	0.999254	8.37	.6702E-05
23	514.00	0.9750	0.9783	0.998123	8.59	.7215E-05
24	518.00	1.0100	1.0091	0.998413	8.75	.7713E-05
25	522.00	1.0450	1.0412	0.998083	8.91	.7890E-05
26	527.00	1.0780	1.0840	0.998472	9.13	.7921E-05
27	531.00	1.1180	1.1158	0.998533	9.30	.7550E-05
28	536.00	1.1550	1.1523	0.998340	9.48	.7115E-05
29	542.00	1.1930	1.1925	0.994702	9.69	.6909E-05
30	548.00	1.2280	1.2300	0.997255	9.89	.6816E-05
31	554.00	1.2650	1.2709	0.997368	10.10	.6910E-05
32	557.00	1.2980	1.2919	0.996996	10.21	.7116E-05
33	563.00	1.3380	1.3350	0.993909	10.43	.8082E-05
34	568.00	1.3700	1.3746	0.991370	10.64	.9918E-05
35	570.00	1.3900	1.3924	0.996934	10.74	.1047E-04
36	575.00	1.4480	1.4496	0.997611	11.05	.1301E-04
37	578.00	1.5000	1.4930	0.998418	11.28	.1465E-04
38	580.00	1.5200	1.5236	0.998367	11.45	.1539E-04
39	583.00	1.5700	1.5720	0.998111	11.72	.1669E-04
40	585.00	1.6080	1.6047	0.998757	11.90	.1739E-04
41	587.00	1.6400	1.6417	0.998662	12.12	.1910E-04
42	589.00	1.6800	1.6804	0.997808	12.34	.1970E-04
43	591.00	1.7180	1.7203	0.996852	12.58	.2011E-04
44	592.00	1.7480	1.7416	0.996933	12.70	.2025E-04
45	593.00	1.7600	1.7620	0.995848	12.83	.2031E-04
46	594.00	1.7900	1.7821	0.994735	12.95	.2050E-04
47	595.00	1.8030	1.8013	0.997713	13.07	.2014E-04
48	596.00	1.8230	1.8235	0.999795	13.21	.2096E-04
49	597.00	1.8450	1.8443	0.999636	13.34	.2107E-04
50	598.00	1.8650	1.8644	0.999178	13.47	.2164E-04
51	599.00	1.8850	1.8860	0.999408	13.61	.2264E-04
52	600.00	1.9080	1.9091	0.999509	13.76	.2357E-04
53	601.00	1.9350	1.9337	0.999591	13.92	.2486E-04
54	602.00	1.9600	1.9605	0.999148	14.10	.2514E-04
55	603.00	1.9850	1.9862	0.999399	14.27	.2464E-04
56	604.00	2.0130	2.0102	0.999139	14.44	.2404E-04
57	605.00	2.0330	2.0321	0.994034	14.59	.2543E-04
58	606.00	2.0550	2.0572	0.995600	14.77	.2646E-04
59	607.00	2.0800	2.0847	0.994563	14.97	.2714E-04
60	608.00	2.1200	2.1147	0.995204	15.19	.2789E-04
61	609.00	2.1450	2.1443	0.997517	15.41	.2768E-04
62	610.00	2.1700	2.1716	0.997587	15.62	.2639E-04
63	611.00	2.1950	2.1952	0.999899	15.81	.2432E-04
64	612.00	2.2200	2.2192	0.999809	16.00	.2404E-04
65	613.00	2.2430	2.2429	0.999782	16.19	.2371E-04
66	614.00	2.2650	2.2660	0.999781	16.39	.2364E-04
67	615.00	2.2900	2.2881	0.997997	16.57	.2511E-04
68	616.00	2.3130	2.3137	0.998539	16.79	.2671E-04
69	617.00	2.3380	2.3418	0.998314	17.04	.2829E-04
70	618.00	2.3750	2.3700	0.997528	17.30	.3125E-04
71	619.00	2.4030	2.4039	0.996892	17.61	.3311E-04
72	620.00	2.4330	2.4374	0.996757	17.94	.3582E-04
73	621.00	2.4800	2.4736	0.996256	18.30	.3705E-04
74	622.00	2.5080	2.5136	0.994674	18.71	.3716E-04
75	623.00	2.5580	2.5521	0.994664	19.12	.3405E-04
76	623.50	2.5700	2.5685	0.991572	19.31	.3230E-04
77	624.00	2.5830	2.5859	0.991366	19.50	.3171E-04
78	624.50	2.5980	2.5967	0.996676	19.63	.3214E-04
79	625.00	2.6130	2.6136	0.997546	19.82	.3614E-04
80	625.50	2.6300	2.6323	0.998068	20.05	.4186E-04
81	626.00	2.6580	2.6551	0.997722	20.33	.4664E-04
82	626.50	2.6780	2.6803	0.998454	20.64	.5193E-04
83	627.00	2.7100	2.7036	0.983642	20.95	.6586E-04
84	627.50	2.7350	2.7367	0.992482	21.39	.7942E-04
85	628.00	2.7680	2.7808	0.992475	22.01	.9467E-04
86	628.50	2.8450	2.8337	0.980284	22.82	.1044E-03
87	629.00	2.8980	2.8920	0.986808	23.78	.1258E-03
88	629.30	2.9280	2.9323	0.977779	24.50	.1479E-03
89	629.60	2.9530	2.9718	0.984816	25.25	.1897E-03
90	629.90	3.0280	3.0299	0.994657	26.46	.2666E-03
91	630.00	3.0630				
92	630.10	3.0930				
93	630.20	3.1180				

* - DATA VIOLATES SIZE REQUIREMENTS

TABLE A43

Fatigue Crack Growth Rate Data Associated with Figure A15

Seven Point Incremental Polynomial Method per ASTM E647

1-07-1988

Specimen Number: 86-131-LT-2 Specimen Type: CCT

B= 0.2500 in W= 3.7590 in An= 0.0000

Pmax= 12.991 kips Pmin= 6.496 kips

R= 0.50 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	Amean*2	Areg	MCC	Delta K	da/dN
1	0.00	0.1860				
2	90.00	0.2130				
3	100.00	0.2430				
4	150.00	0.3210	0.3477	0.968439	5.13	.2702E-05
5	162.50	0.3660	0.3812	0.983353	5.38	.3948E-05
6	175.00	0.4310	0.4344	0.998519	5.76	.5858E-05
7	180.00	0.4610	0.4622	0.999807	5.94	.6791E-05
8	185.00	0.4960	0.4974	0.999810	6.18	.7496E-05
9	190.00	0.5380	0.5366	0.999737	6.43	.8211E-05
10	193.00	0.5630	0.5621	0.999370	6.59	.8884E-05
11	196.00	0.5880	0.5897	0.998953	6.75	.9188E-05
12	199.00	0.6160	0.6177	0.998889	6.92	.9512E-05
13	202.00	0.6510	0.6469	0.998984	7.10	.1000E-04
14	205.00	0.6760	0.6772	0.998671	7.27	.1067E-04
15	208.00	0.7080	0.7090	0.998634	7.46	.1148E-04
16	211.00	0.7430	0.7436	0.999152	7.66	.1221E-04
17	214.00	0.7830	0.7829	0.999396	7.88	.1314E-04
18	216.00	0.8130	0.8106	0.998943	8.03	.1313E-04
19	218.00	0.8360	0.8371	0.997654	8.18	.1382E-04
20	220.00	0.8660	0.8631	0.996837	8.32	.1477E-04
21	222.00	0.8880	0.8934	0.995546	8.48	.1523E-04
22	224.00	0.9260	0.9263	0.994385	8.66	.1563E-04
23	226.00	0.9660	0.9587	0.994334	8.84	.1568E-04
24	227.50	0.9810	0.9835	0.995275	8.97	.1609E-04
25	229.00	1.0030	1.0057	0.995742	9.09	.1596E-04
26	230.50	1.0280	1.0280	0.998612	9.21	.1617E-04
27	232.00	1.0560	1.0543	0.999721	9.35	.1748E-04
28	233.50	1.0810	1.0805	0.998869	9.49	.1883E-04
29	235.00	1.1080	1.1092	0.999172	9.65	.1993E-04
30	236.50	1.1380	1.1404	0.998524	9.81	.2067E-04
31	238.00	1.1760	1.1728	0.998891	9.99	.2193E-04
32	239.50	1.2080	1.2065	0.998958	10.17	.2314E-04
33	241.00	1.2380	1.2415	0.999043	10.36	.2414E-04
34	242.50	1.2780	1.2772	0.999711	10.55	.2526E-04
35	244.00	1.3180	1.3171	0.999391	10.77	.2657E-04
36	245.50	1.3580	1.3595	0.999642	11.00	.2713E-04
37	247.00	1.4030	1.4003	0.999380	11.23	.2770E-04
38	248.00	1.4280	1.4282	0.999275	11.38	.2794E-04
39	249.00	1.4530	1.4559	0.998987	11.54	.2868E-04
40	250.00	1.4860	1.4842	0.999074	11.70	.2879E-04
41	251.00	1.5130	1.5140	0.999318	11.87	.2979E-04
42	252.00	1.5460	1.5439	0.999036	12.04	.3107E-04
43	253.00	1.5730	1.5741	0.999309	12.22	.3232E-04
44	254.00	1.6060	1.6072	0.999598	12.41	.3443E-04
45	255.00	1.6430	1.6424	0.999695	12.62	.3629E-04
46	256.00	1.6810	1.6807	0.999940	12.85	.3882E-04
47	257.00	1.7210	1.7207	0.999923	13.10	.4047E-04
48	258.00	1.7610	1.7622	0.999495	13.36	.4093E-04
49	259.00	1.8060	1.8039	0.998710	13.63	.3903E-04
50	259.50	1.8260	1.8241	0.998876	13.76	.3778E-04
51	260.00	1.8430	1.8426	0.993102	13.88	.4001E-04
52	260.50	1.8580	1.8598	0.996519	13.99	.4143E-04
53	261.00	1.8780	1.8825	0.988168	14.14	.4150E-04
54	261.50	1.9080	1.9049	0.990191	14.29	.4286E-04
55	262.00	1.9330	1.9269	0.989393	14.44	.4600E-04
56	262.50	1.9430	1.9479	0.988194	14.59	.4964E-04
57	263.00	1.9680	1.9721	0.992080	14.76	.5100E-04
58	263.50	2.0010	1.9995	0.990864	14.96	.5407E-04
59	264.00	2.0360	2.0304	0.997400	15.18	.5907E-04
60	264.50	2.0580	2.0617	0.996383	15.41	.5671E-04
61	265.00	2.0860	2.0866	0.990364	15.60	.5843E-04
62	265.50	2.1210	2.1146	0.993064	15.82	.6043E-04
63	266.00	2.1360	2.1470	0.993258	16.07	.6293E-04
64	266.50	2.1860	2.1794	0.993917	16.33	.6779E-04
65	267.00	2.2160	2.2154	0.992108	16.63	.6836E-04
66	267.50	2.2480	2.2514	0.994408	16.93	.7321E-04
67	268.00	2.2910	2.2847	0.997267	17.22	.7404E-04
68	268.50	2.3160	2.3231	0.997122	17.57	.7915E-04
69	269.00	2.3660	2.3639	0.996785	17.95	.8395E-04
70	269.30	2.3910	2.3879	0.995964	18.18	.9335E-04
71	269.60	2.4160	2.4187	0.996361	18.48	.9841E-04
72	269.90	2.4430	2.4462	0.997025	18.76	.1055E-03
73	270.20	2.4860	2.4790	0.997608	19.10	.1176E-03
74	270.50	2.5110	2.5161	0.997801	19.50	.1321E-03
75	270.80	2.5580	2.5570	0.997440	19.96	.1508E-03
76	271.10	2.6030	2.6026	0.999162	20.50	.1756E-03
77	271.30	2.6380	2.6406	0.999196	20.97	.1959E-03
78	271.50	2.6810	2.6807	0.999687	21.49	.2286E-03
79	271.60	2.7030	2.7037	0.999778	21.80	.2499E-03
80	271.70	2.7280	2.7285	0.996521	22.15	.2933E-03
81	271.80	2.7580				
82	271.90	2.7880				
83	272.00	2.8380				

* - DATA VIOLATES SIZE REQUIREMENTS

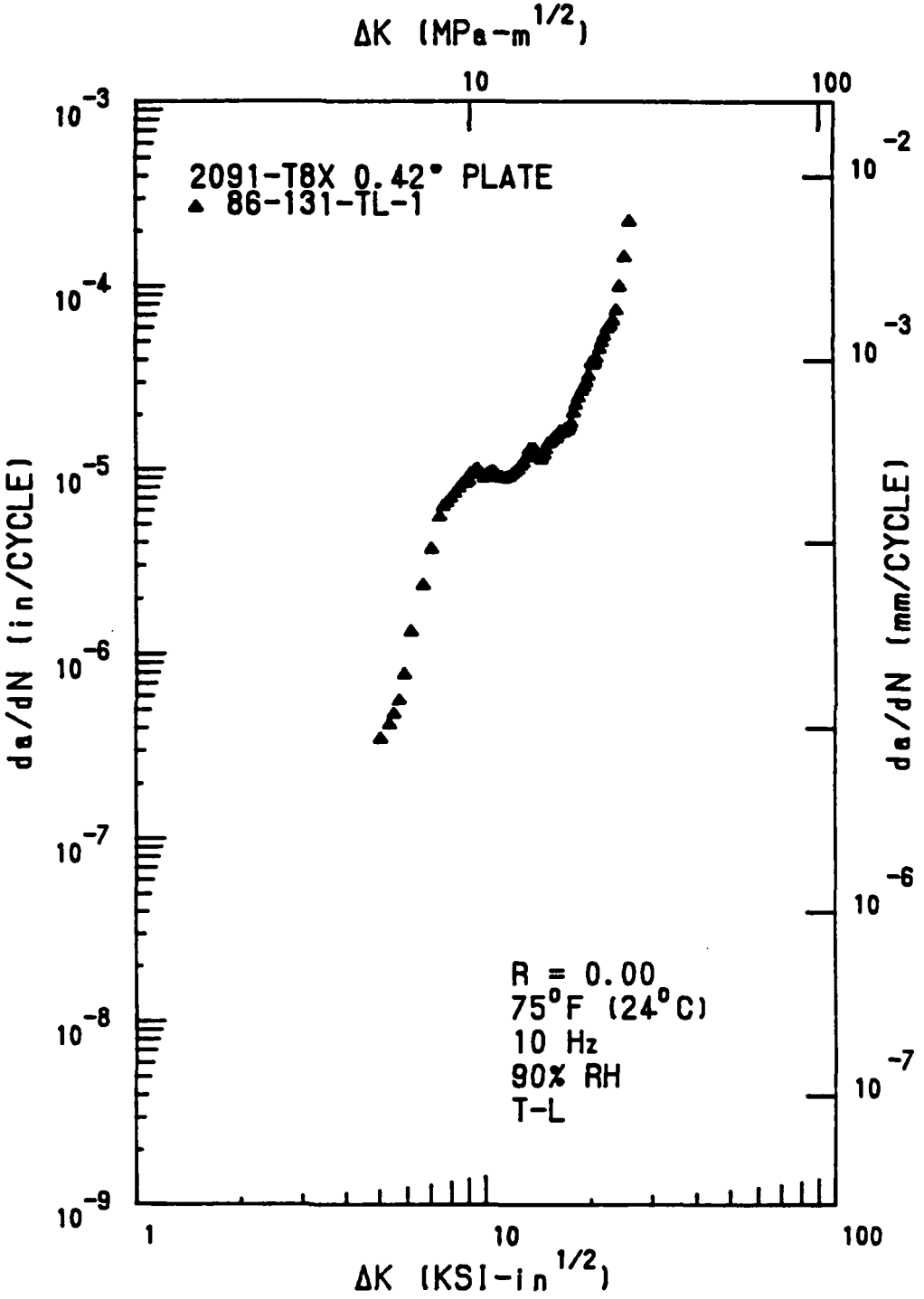


Figure A16 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.42" Plate (T-L Orientation). Grumman.

TABLE A44

Fatigue Crack Growth Rate Data Associated with Figure A16

Seven Point Incremental Polynomial Method per ASTM E647

1-14-1988

Specimen Number: 86-131-TL-1 Specimen Type: CCT

B= 0.2500 in W= 3.7540 in An= 0.0000

P_{max}= 6.765 kips Pmin= 0.000 kips

R= 0.00 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH.

PT	CYCLES	Amean+2	Area	MCC	Delta K	da/dN
1	0.00	0.2210				
2	100.00	0.2460				
3	225.00	0.2730				
4	325.00	0.3060	0.3066	0.999057	5.02	.3457E-06
5	425.00	0.3430	0.3430	0.999641	5.32	.4122E-06
6	475.00	0.3660	0.3664	0.998706	5.49	.4698E-06
7	525.00	0.3860	0.3874	0.996682	5.66	.5562E-06
8	575.00	0.4130	0.4112	0.971974	5.84	.7746E-06
9	625.00	0.4480	0.4488	0.950143	6.11	.1315E-05
10	675.00	0.4930	0.5254	0.959589	6.63	.2332E-05
11	700.00	0.5660	0.5879	0.976209	7.03	.3647E-05
12	715.00	0.6460	0.6469	0.998410	7.40	.5477E-05
13	720.00	0.6730	0.6733	0.999727	7.56	.6211E-05
14	725.00	0.7060	0.7065	0.999812	7.76	.6502E-05
15	730.00	0.7410	0.7397	0.999720	7.96	.6907E-05
16	735.00	0.7760	0.7756	0.999795.	8.17	.7328E-05
17	740.00	0.8110	0.8126	0.999602	8.39	.7843E-05
18	745.00	0.8530	0.8525	0.999457	8.62	.8274E-05
19	747.50	0.8730	0.8727	0.999198	8.74	.8794E-05
20	750.00	0.8980	0.8958	0.999243	8.86	.8717E-05
21	752.50	0.9160	0.9160	0.997085	8.98	.8643E-05
22	755.00	0.9380	0.9363	0.995186	9.09	.9429E-05
23	757.50	0.9560	0.9627	0.990407	9.24	.9126E-05
24	760.00	0.9860	0.9873	0.992236	9.38	.9796E-05
25	762.50	1.0210	1.0132	0.994419	9.52	.9938E-05
26	767.50	1.0560	1.0626	0.995740	9.80	.9731E-05
27	770.00	1.0860	1.0841	0.995452	9.92	.8927E-05
28	772.50	1.1060	1.1046	0.997103	10.04	.8991E-05
29	775.00	1.1280	1.1282	0.997157	10.17	.9186E-05
30	777.50	1.1480	1.1503	0.998277	10.29	.9400E-05
31	780.00	1.1760	1.1752	0.998758	10.43	.9603E-05
32	782.50	1.2010	1.2004	0.998969	10.57	.9700E-05
33	785.00	1.2260	1.2257	0.999913	10.71	.9514E-05
34	787.50	1.2480	1.2479	0.999098	10.84	.9300E-05
35	790.00	1.2710	1.2712	0.998665	10.97	.8937E-05
36	792.50	1.2910	1.2924	0.998456	11.09	.8866E-05
37	795.00	1.3180	1.3146	0.998751	11.22	.8875E-05
38	798.00	1.3380	1.3415	0.998860	11.37	.8844E-05
39	802.00	1.3780	1.3762	0.998732	11.57	.8956E-05
40	806.00	1.4130	1.4119	0.999072	11.78	.9005E-05
41	810.00	1.4460	1.4487	0.995277	11.99	.9366E-05
42	814.00	1.4880	1.4853	0.999644	12.21	.9624E-05
43	818.00	1.5250	1.5252	0.999311	12.45	.9870E-05
44	822.00	1.5660	1.5653	0.998936	12.69	.1047E-04
45	825.50	1.6040	1.6015	0.999148	12.91	.1081E-04
46	829.00	1.6360	1.6402	0.998831	13.15	.1164E-04
47	832.50	1.6830	1.6805	0.999093	13.41	.1274E-04
48	835.00	1.7110	1.7139	0.995633	13.62	.1279E-04
49	837.50	1.7480	1.7495	0.996952	13.85	.1286E-04
50	840.00	1.7880	1.7816	0.996305	14.07	.1329E-04
51	842.50	1.8080	1.8124	0.996459	14.27	.1179E-04
52	845.00	1.8410	1.8393	0.995681	14.46	.1125E-04
53	847.00	1.8580	1.8590	0.997644	14.59	.1164E-04
54	849.00	1.8830	1.8840	0.996607	14.77	.1176E-04
55	851.00	1.9060	1.9065	0.998033	14.93	.1279E-04
56	853.00	1.9380	1.9741	0.996057	15.13	.1266E-04
57	855.00	1.9560	1.9625	0.994868	15.23	.1284E-04
58	857.00	1.9760	1.9910	0.994779	15.54	.1418E-04
59	858.50	2.0130	2.0117	0.994358	15.70	.1457E-04
60	860.00	2.0310	2.0352	0.995450	15.89	.1494E-04
61	861.50	2.0560	2.0553	0.998407	16.04	.1467E-04
62	863.00	2.0810	2.0787	0.999036	16.22	.1545E-04
63	864.50	2.1010	2.1025	0.999242	16.41	.1610E-04
64	866.00	2.1260	2.1270	0.998770	16.61	.1591E-04
65	867.50	2.1510	2.1507	0.998369	16.80	.1576E-04
66	869.00	2.1700	2.1743	0.997280	17.00	.1645E-04
67	870.50	2.1960	2.1992	0.996763	17.22	.1624E-04
68	872.00	2.2210	2.2224	0.995765	17.42	.1710E-04
69	873.50	2.2520	2.2480	0.996794	17.65	.1781E-04
70	875.00	2.2710	2.2748	0.994932	17.89	.2026E-04
71	876.50	2.3080	2.3057	0.996261	18.18	.2206E-04
72	878.00	2.3360	2.3406	0.996279	18.51	.2421E-04
73	879.50	2.3960	2.3819	0.997580	18.92	.2681E-04
74	880.50	2.4110	2.4089	0.997571	19.20	.2833E-04
75	881.50	2.4360	2.4291	0.997484	19.51	.2992E-04
76	882.50	2.4660	2.4665	0.999557	19.81	.3353E-04
77	883.50	2.5010	2.5004	0.999462	20.17	.3814E-04
78	884.00	2.5180	2.5210	0.995923	20.42	.3714E-04
79	884.50	2.5410	2.5408	0.996498	20.65	.3813E-04
80	885.00	2.5660	2.5590	0.991507	20.87	.4061E-04
81	886.00	2.5960	2.6005	0.992429	21.28	.4521E-04
82	886.50	2.6180	2.6221	0.995487	21.66	.4746E-04
83	887.00	2.6520	2.6472	0.996650	21.99	.5123E-04
84	887.50	2.6760	2.6777	0.998659	22.41	.5857E-04
85	888.00	2.7080	2.7083	0.998892	22.84	.6056E-04
86	888.50	2.7380	2.7367	0.997805	23.25	.6479E-04
87	889.00	2.7710	2.7694	0.997141	23.76	.7339E-04
88	889.50	2.8010	2.8050	0.987227	24.30	.9994E-04
89	890.00	2.8510	2.8550	0.986229	25.19	.1431E-03
90	890.20	2.8810	2.8997	0.968204	26.00	.2241E-03
91	890.60	2.9610				
92	890.70	2.9910				
93	890.80	3.0610				

* - DATA VIOLATES SIZE REQUIREMENTS

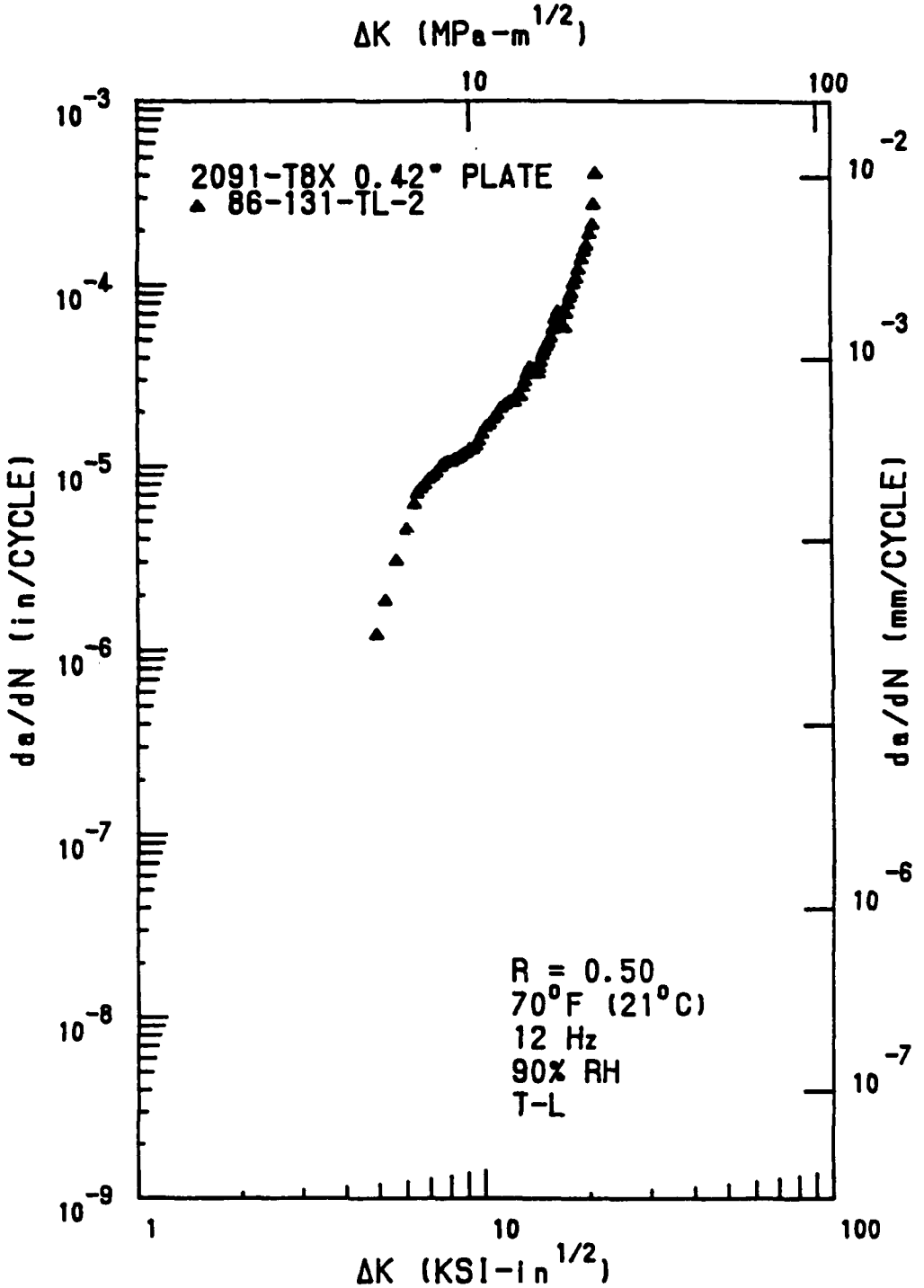


Figure A17 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.42" Plate (T-L Orientation). Grumman.

TABLE A45

Fatigue Crack Growth Rate Data Associated with Figure A17

Seven Point Incremental Polynomial Method per ASTM E647

11-14-1988

Specimen Number: B6-131-TL-2 Specimen Type: CCT

B= 0.2500 in W= 3.7590 in An= 0.0000

Pmax= 14.435 kips Pmin= 7.218 kips

R= 0.50 Frequency= 12.00 hz.

Test Temperature= 70 F Environment= 90% RH

PT	CYCLES	Amess*2	Areg	MCC	Delta K	da/dN
1	0.00	0.1910				
2	50.00	0.2080				
3	100.00	0.2380				
4	125.00	0.2530	0.2568	0.971287	4.89	.1210E-05
5	150.00	0.2780	0.2872	0.969194	5.18	.1847E-05
6	175.00	0.3210	0.3336	0.987310	5.59	.3040E-05
7	190.00	0.3760	0.3840	0.993097	6.00	.4459E-05
8	197.50	0.4180	0.4206	0.997124	6.29	.6156E-05
9	200.50	0.4360	0.4381	0.998832	6.42	.7046E-05
10	203.50	0.4580	0.4597	0.998036	6.59	.7488E-05
11	206.50	0.4880	0.4841	0.998055	6.77	.7905E-05
12	209.50	0.5080	0.5084	0.997851	6.94	.8452E-05
13	212.50	0.5330	0.5339	0.997992	7.12	.8761E-05
14	215.50	0.5580	0.5594	0.999343	7.30	.9194E-05
15	218.50	0.5910	0.5887	0.999481	7.50	.9881E-05
16	221.00	0.6130	0.6142	0.999508	7.67	.1032E-04
17	223.50	0.6410	0.6413	0.999486	7.85	.1055E-04
18	226.00	0.6680	0.6679	0.999294	8.02	.1051E-04
19	228.50	0.6960	0.6945	0.999265	8.19	.1083E-04
20	231.00	0.7210	0.7209	0.999290	8.36	.1101E-04
21	233.50	0.7460	0.7486	0.999384	8.54	.1121E-04
22	236.00	0.7780	0.7766	0.999496	8.71	.1163E-04
23	238.50	0.8080	0.8074	0.999027	8.90	.1183E-04
24	241.00	0.8360	0.8369	0.998235	9.08	.1237E-04
25	243.50	0.8700	0.8681	0.997960	9.27	.1234E-04
26	246.00	0.8950	0.8984	0.997426	9.46	.1296E-04
27	248.50	0.9360	0.9309	0.997602	9.65	.1380E-04
28	251.00	0.9610	0.9650	0.998209	9.86	.1499E-04
29	253.50	1.0050	1.0048	0.998365	10.10	.1633E-04
30	256.00	1.0460	1.0476	0.997434	10.35	.1694E-04
31	258.50	1.0960	1.0932	0.999193	10.62	.1817E-04
32	261.00	1.1410	1.1378	0.998649	10.89	.1911E-04
33	263.50	1.1810	1.1848	0.998329	11.17	.2079E-04
34	266.00	1.2360	1.2377	0.997216	11.49	.2176E-04
35	268.50	1.2960	1.2953	0.995795	11.83	.2268E-04
36	271.00	1.3660	1.3559	0.997131	12.20	.2253E-04
37	272.20	1.3790	1.3834	0.992412	12.37	.2438E-04
38	273.40	1.4060	1.4115	0.990814	12.54	.2494E-04
39	274.60	1.4360	1.4402	0.989911	12.72	.2408E-04
40	275.80	1.4810	1.4713	0.989726	12.92	.2717E-04
41	277.00	1.5060	1.5032	0.989483	13.12	.2955E-04
42	278.20	1.5260	1.5379	0.990826	13.34	.3232E-04
43	279.40	1.5800	1.5755	0.992678	13.58	.3512E-04
44	280.60	1.6260	1.6221	0.985759	13.89	.3438E-04
45	281.20	1.6510	1.6472	0.996812	14.06	.3256E-04
46	281.80	1.6660	1.6650	0.990152	14.18	.3277E-04
47	282.40	1.6760	1.6820	0.991462	14.29	.3244E-04
48	283.00	1.7010	1.7000	0.996653	14.41	.3482E-04
49	283.60	1.7260	1.7236	0.993163	14.58	.3780E-04
50	284.20	1.7460	1.7486	0.990393	14.75	.4107E-04
51	284.80	1.7760	1.7722	0.997824	14.91	.4345E-04
52	285.40	1.7960	1.7986	0.998401	15.10	.4613E-04
53	286.00	1.8260	1.8286	0.997283	15.32	.4792E-04
54	286.60	1.8610	1.8567	0.996644	15.52	.5119E-04
55	287.20	1.8910	1.8888	0.995891	15.76	.5482E-04
56	287.80	1.9160	1.9222	0.994889	16.01	.6518E-04
57	288.40	1.9610	1.9617	0.993159	16.32	.7120E-04
58	288.70	1.9860	1.9846	0.982433	16.50	.6545E-04
59	289.00	2.0160	2.0081	0.991679	16.69	.6073E-04
60	289.30	2.0260	2.0253	0.977436	16.83	.5893E-04
61	289.60	2.0360	2.0389	0.976922	16.94	.5833E-04
62	289.90	2.0510	2.0546	0.991500	17.07	.5833E-04
63	290.20	2.0760	2.0736	0.993804	17.22	.6964E-04
64	290.50	2.1010	2.0972	0.995755	17.42	.7857E-04
65	290.80	2.1160	2.1222	0.996567	17.64	.8512E-04
66	291.10	2.1510	2.1479	0.997234	17.86	.8929E-04
67	291.40	2.1760	2.1741	0.995687	18.10	.1012E-03
68	291.70	2.2060	2.2080	0.993677	18.41	.1092E-03
69	292.00	2.2360	2.2389	0.993005	18.70	.1214E-03
70	292.30	2.2860	2.2775	0.993392	19.07	.1383E-03
71	292.50	2.2960	2.3058	0.993665	19.35	.1527E-03
72	292.70	2.3410	2.3378	0.992835	19.67	.1641E-03
73	292.90	2.3710	2.3693	0.992001	20.00	.1897E-03
74	293.10	2.4110	2.4122	0.994226	20.47	.2126E-03
75	293.20	2.4260	2.4306	0.987670	20.67	.2752E-03
76	293.30	2.4610	2.4569	0.958966	20.97	.4066E-03
77	293.40	2.4810				
78	293.50	2.5410				
79	293.55	2.6160				

* - DATA VIOLATES SIZE REQUIREMENTS

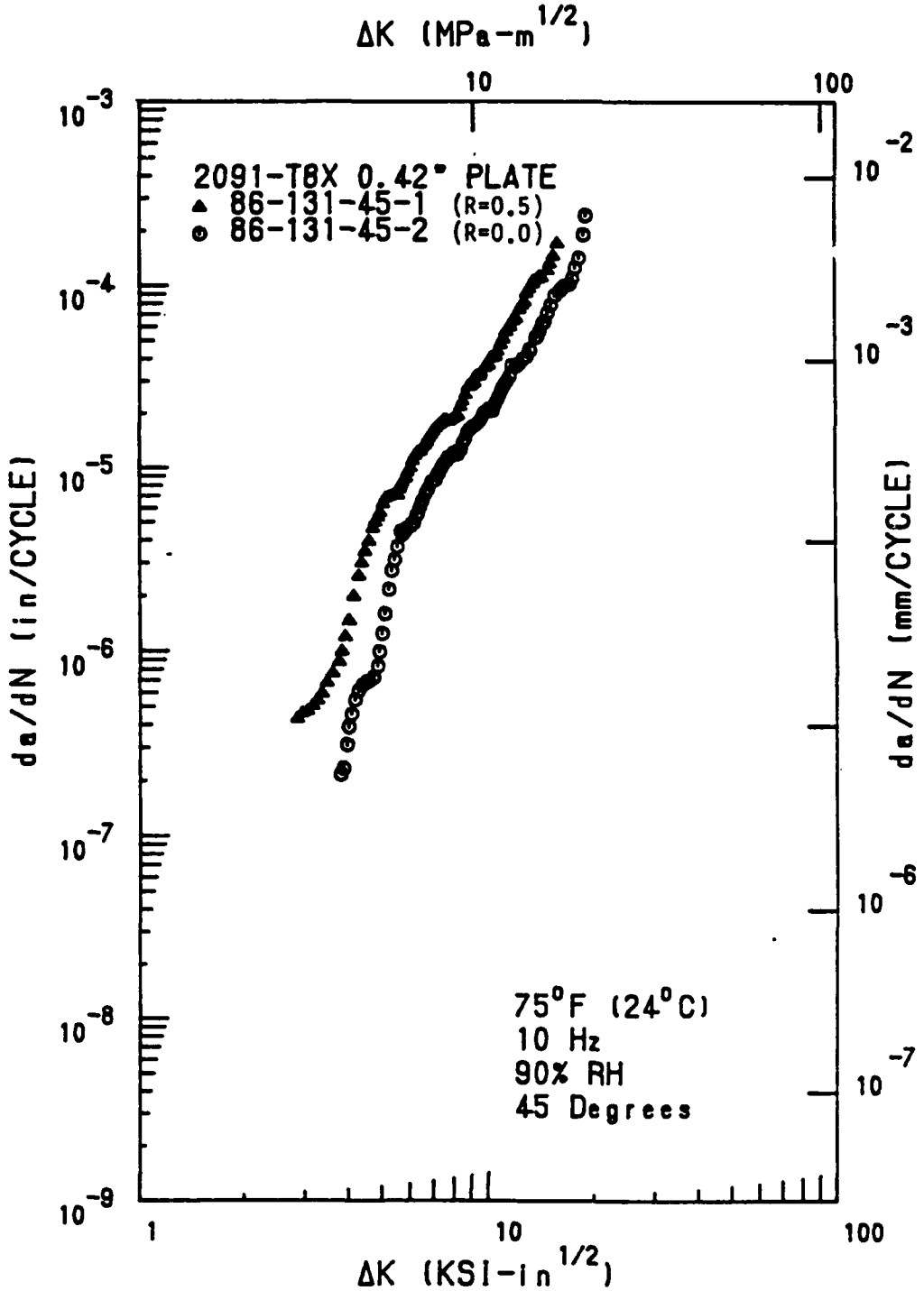


Figure A18 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.42" Plate (45 degrees Orientation). Grumman.

TABLE A46

Fatigue Crack Growth Rate Data Associated with Figure A18

Seven Point Incremental Polynomial Method per ASTM E647

1-15-1988

Specimen Number: 86-131-45-1 Specimen Type: CCT

B= 0.2500 in W= 3.7530 in An= 0.0600

Pmax= 7.375 kips Pmin= 3.688 kips

R= 0.50 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	Ameas*2	Areg	MCC	Delta K	da/dN
1	0.00	0.2750				
2	50.00	0.2900				
3	100.00	0.3130				
4	150.00	0.3330	0.3321	0.999225	2.85	.4286E-06
5	200.00	0.3530	0.3545	0.999409	2.95	.4607E-06
6	250.00	0.3780	0.3780	0.999261	3.05	.4743E-06
7	300.00	0.4030	0.4024	0.999276	3.15	.5057E-06
8	350.00	0.4300	0.4282	0.999130	3.25	.5421E-06
9	400.00	0.4530	0.4549	0.999050	3.35	.5893E-06
10	450.00	0.4850	0.4841	0.998128	3.46	.6753E-06
11	500.00	0.5180	0.5192	0.998159	3.59	.7601E-06
12	550.00	0.5580	0.5602	0.998047	3.74	.8758E-06
13	575.00	0.5880	0.5822	0.996666	3.81	.9944E-06
14	600.00	0.6030	0.6070	0.992261	3.90	.1192E-05
15	625.00	0.6330	0.6350	0.994222	4.00	.1447E-05
16	650.00	0.6700	0.6716	0.998336	4.12	.1967E-05
17	670.00	0.7130	0.7150	0.998613	4.26	.2536E-05
18	680.00	0.7380	0.7402	0.999224	4.34	.2999E-05
19	690.00	0.7730	0.7712	0.999473	4.44	.3453E-05
20	700.00	0.8050	0.8074	0.999472	4.56	.3917E-05
21	710.00	0.8500	0.8493	0.998800	4.69	.4602E-05
22	715.00	0.8730	0.8722	0.999202	4.76	.4970E-05
23	720.00	0.8950	0.8984	0.999185	4.84	.5304E-05
24	725.00	0.9280	0.9254	0.999198	4.92	.5629E-05
25	730.00	0.9550	0.9536	0.997909	5.01	.6279E-05
26	735.00	0.9850	0.9870	0.997856	5.11	.6757E-05
27	740.00	1.0180	1.0225	0.996167	5.22	.6900E-05
28	745.00	1.0650	1.0598	0.996528	5.33	.7005E-05
29	750.00	1.0980	1.0961	0.995882	5.45	.7127E-05
30	755.00	1.1280	1.1317	0.994457	5.55	.7037E-05
31	757.50	1.1430	1.1468	0.997146	5.60	.7598E-05
32	760.00	1.1700	1.1657	0.996997	5.66	.7942E-05
33	762.50	1.1850	1.1875	0.997133	5.72	.8286E-05
34	765.00	1.2100	1.2083	0.996945	5.79	.8732E-05
35	767.50	1.2300	1.2295	0.998447	5.85	.8793E-05
36	770.00	1.2500	1.2523	0.998846	5.92	.9410E-05
37	773.00	1.2830	1.2801	0.999431	6.01	.9993E-05
38	776.00	1.3100	1.3114	0.999539	6.11	.1094E-04
39	779.00	1.3450	1.3462	0.999207	6.21	.1166E-04
40	782.00	1.3830	1.3822	0.998908	6.33	.1212E-04
41	785.00	1.4230	1.4208	0.999693	6.45	.1239E-04
42	787.00	1.4450	1.4454	0.998228	6.53	.1305E-04
43	789.00	1.4700	1.4711	0.998353	6.61	.1332E-04
44	791.00	1.4950	1.4971	0.998880	6.70	.1395E-04
45	793.00	1.5300	1.5269	0.998661	6.79	.1462E-04
46	795.00	1.5550	1.5570	0.998898	6.89	.1527E-04
47	797.00	1.5900	1.5881	0.998967	7.00	.1586E-04
48	799.00	1.6180	1.6187	0.999349	7.10	.1659E-04
49	801.00	1.6530	1.6541	0.998701	7.22	.1723E-04
50	803.00	1.6880	1.6891	0.998589	7.34	.1756E-04
51	805.00	1.7300	1.7256	0.998930	7.47	.1826E-04
52	807.00	1.7600	1.7625	0.998794	7.60	.1834E-04
53	808.50	1.7880	1.7904	0.998291	7.70	.1796E-04
54	810.00	1.8200	1.8163	0.998159	7.80	.1802E-04
55	811.50	1.8450	1.8441	0.998394	7.90	.1862E-04
56	813.00	1.8680	1.8714	0.998603	8.00	.1883E-04
57	814.50	1.9000	1.8992	0.999307	8.11	.1910E-04
58	816.00	1.9300	1.9297	0.998764	8.23	.1938E-04
59	817.50	1.9600	1.9571	0.999012	8.34	.2169E-04
60	819.00	1.9900	1.9892	0.993687	8.47	.2330E-04
61	820.50	2.0150	2.0251	0.993542	8.62	.2532E-04
62	822.00	2.0750	2.0650	0.993094	8.78	.2800E-04
63	823.40	2.1080	2.1070	0.991796	8.97	.2840E-04
64	824.10	2.1250	2.1295	0.992291	9.07	.2947E-04
65	824.80	2.1500	2.1470	0.996897	9.15	.2954E-04
66	825.50	2.1650	2.1684	0.996663	9.24	.3194E-04
67	826.20	2.1950	2.1934	0.995228	9.36	.3205E-04
68	826.90	2.2130	2.2152	0.995049	9.46	.3224E-04
69	827.60	2.2430	2.2374	0.994614	9.57	.3357E-04
70	829.00	2.2780	2.2829	0.996699	9.79	.3565E-04
71	829.70	2.3080	2.3089	0.995996	9.93	.3647E-04
72	830.40	2.3380	2.3344	0.995868	10.06	.3697E-04
73	831.10	2.3650	2.3628	0.996890	10.21	.4026E-04
74	831.80	2.3880	2.3901	0.997660	10.36	.4061E-04
75	832.50	2.4150	2.4186	0.998019	10.52	.4138E-04
76	833.20	2.4530	2.4480	0.998151	10.69	.4378E-04
77	833.90	2.4800	2.4793	0.997655	10.88	.4786E-04
78	834.60	2.5100	2.5134	0.997908	11.09	.5104E-04
79	835.30	2.5480	2.5480	0.999376	11.31	.5633E-04
80	836.00	2.5930	2.5910	0.997741	11.60	.5982E-04
81	836.50	2.6200	2.6227	0.997708	11.82	.6401E-04
82	837.00	2.6600	2.6556	0.997289	12.05	.6628E-04
83	837.60	2.6900	2.6954	0.995728	12.35	.7378E-04
84	837.90	2.7200	2.7177	0.995416	12.53	.7857E-04
85	838.20	2.7380	2.7406	0.996199	12.72	.8152E-04
86	838.50	2.7700	2.7678	0.995232	12.94	.9119E-04
87	838.80	2.7950	2.7947	0.996039	13.18	.9640E-04
88	839.10	2.8200	2.8256	0.996523	13.46	.1027E-03
89	839.20	2.8400	2.8347	0.996920	13.54	.1054E-03
90	839.50	2.8680	2.8696	0.995350	13.88	.1085E-03
91	839.70	2.8900	2.8920	0.996197	14.10	.1113E-03
92	839.90	2.9180	2.9116	0.995934	14.31	.1111E-03
93	840.30	2.9530	2.9580	0.995961	14.82	.1212E-03
94	840.50	2.9800	2.9814	0.996335	15.09	.1327E-03
95	840.70	3.0130	3.0078	0.998110	15.42	.1446E-03
96	840.90	3.0350	3.0374	0.995796	15.80	.1700E-03
97	841.10	3.0730				
98	841.30	3.1080				
99	841.50	3.1650				

* - DATA VIOLATES SIZE REQUIREMENTS

TABLE A47

Fatigue Crack Growth Rate Data Associated with Figure A18

Seven Point Incremental Polynomial Method per ASTM E647

11-16-1988

Specimen Number: 86-131-45-2 Specimen Type: CCT

B= 0.2400 in W= 3.7530 in An= 0.0000

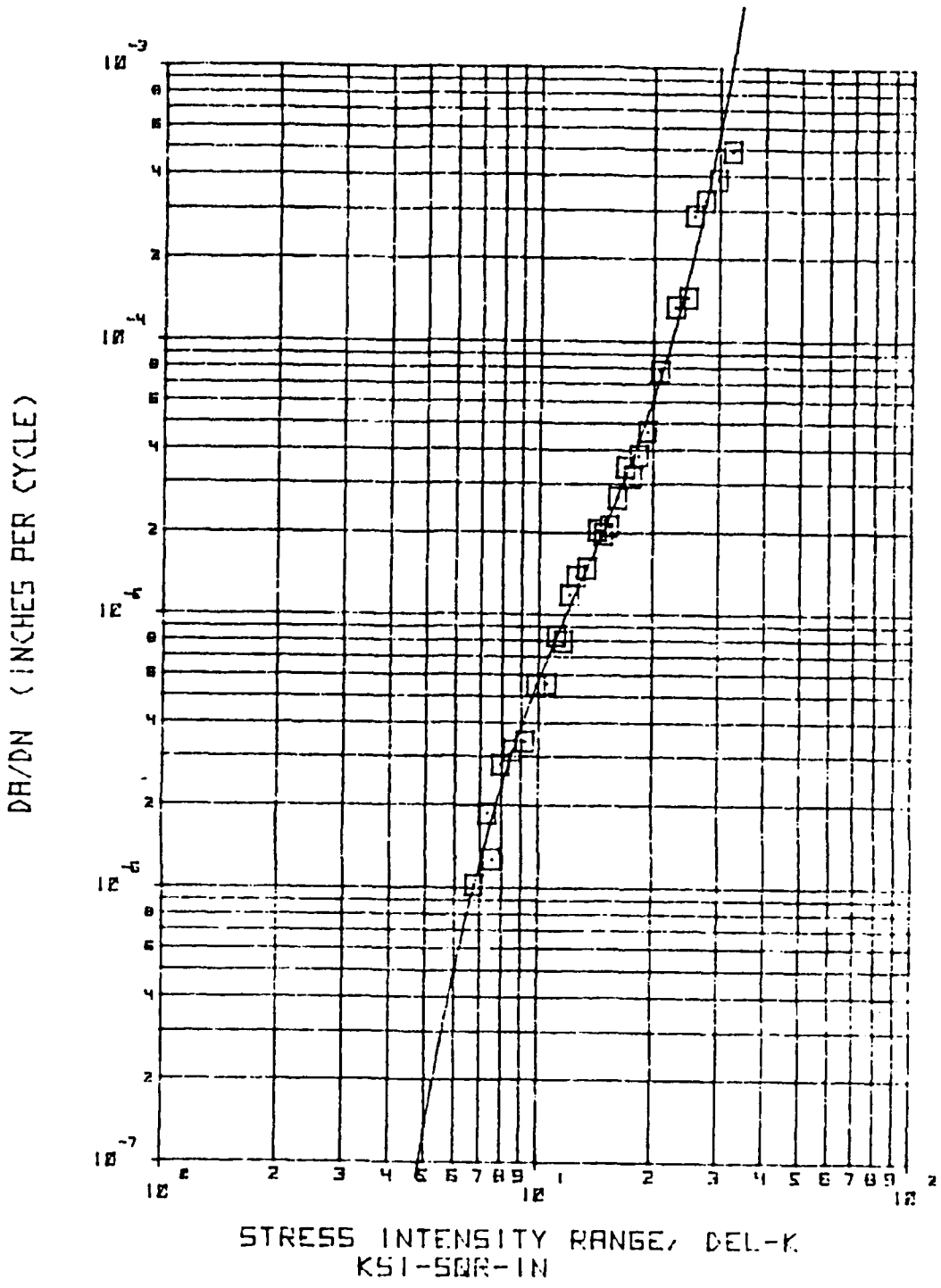
Pmax= 3.657 kips Pmin= 0.000 kips

R= 0.00 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	Ameas*2	Areg	MCC	Delta K	da/dN
1	0.00	0.4960				
2	75.00	0.5110				
3	150.00	0.5280				
4	200.00	0.5460	0.5405	0.988252	3.79	.2161E-06
5	300.00	0.5610	0.5602	0.977592	3.86	.2331E-06
6	400.00	0.5760	0.5821	0.982605	3.94	.3118E-06
7	450.00	0.5960	0.5967	0.996674	3.99	.3877E-06
8	500.00	0.6180	0.6169	0.997893	4.06	.4534E-06
9	550.00	0.6430	0.643[illegible]	0.999352	4.16	.5429E-06
10	600.00	0.6730	0.6716	0.999447	4.25	.6073E-06
11	650.00	0.7010	0.7043	0.998739	4.37	.6515E-06
12	700.00	0.7410	0.7386	0.998640	4.48	.6808E-06
13	725.00	0.7580	0.7568	0.998719	4.54	.6824E-06
14	775.00	0.7910	0.7916	0.997150	4.66	.7158E-06
15	800.00	0.8080	0.8075	0.998418	4.71	.7205E-06
16	850.00	0.8410	0.8446	0.997784	4.83	.8310E-06
17	875.00	0.8680	0.8637	0.996068	4.89	.9904E-06
18	900.00	0.8860	0.8890	0.992633	4.97	.1241E-05
19	925.00	0.9160	0.9190	0.994569	5.07	.1589E-05
20	950.00	0.9580	0.9609	0.999448	5.20	.2163E-05
21	965.00	0.9960	0.9956	0.998690	5.31	.2729E-05
22	975.00	1.0230	1.0234	0.999273	5.40	.3112E-05
23	985.00	1.0530	1.0559	0.998238	5.50	.3666E-05
24	995.00	1.0960	1.0939	0.998852	5.62	.4451E-05
25	1000.00	1.1130	1.1182	0.992742	5.70	.4243E-05
26	1005.00	1.1430	1.1415	0.994813	5.77	.4455E-05
27	1010.00	1.1710	1.1635	0.993093	5.84	.4600E-05
28	1020.00	1.2030	1.2100	0.995290	5.99	.4733E-05
29	1025.00	1.2310	1.2318	0.996092	6.05	.4881E-05
30	1030.00	1.2610	1.2564	0.995333	6.13	.4934E-05
31	1035.00	1.2830	1.2837	0.996624	6.22	.5414E-05
32	1040.00	1.3110	1.3098	0.997418	6.30	.5571E-05
33	1045.00	1.3330	1.3360	0.998059	6.39	.6121E-05
34	1050.00	1.3710	1.3698	0.996311	6.50	.6551E-05
35	1055.00	1.4010	1.4038	0.996433	6.61	.7143E-05
36	1060.00	1.4480	1.4425	0.997202	6.74	.7630E-05
37	1066.00	1.4830	1.4885	0.996510	6.89	.8345E-05
38	1069.00	1.5160	1.5145	0.995492	6.98	.8412E-05
39	1072.00	1.5380	1.5387	0.995783	7.06	.8617E-05
40	1075.00	1.5710	1.5673	0.997574	7.16	.9131E-05
41	1078.00	1.5910	1.5930	0.998152	7.24	.9357E-05
42	1081.00	1.6210	1.6215	0.998351	7.34	.9988E-05
43	1084.00	1.6510	1.6515	0.999273	7.45	.1048E-04
44	1087.00	1.6860	1.6865	0.998849	7.58	.1090E-04
45	1090.00	1.7210	1.7192	0.998286	7.69	.1137E-04
46	1093.00	1.7560	1.7541	0.998223	7.82	.1159E-04
47	1096.00	1.7830	1.7881	0.998032	7.95	.1201E-04
48	1099.00	1.8280	1.8245	0.997374	8.09	.1220E-04
49	1101.00	1.8480	1.8498	0.995884	8.18	.1193E-04
50	1103.00	1.8780	1.8749	0.995960	8.28	.1242E-04
51	1105.00	1.8980	1.8970	0.996348	8.37	.1270E-04
52	1107.00	1.9180	1.9226	0.996983	8.47	.1370E-04
53	1109.00	1.9510	1.9503	0.997873	8.59	.1437E-04
54	1111.00	1.9820	1.9816	0.998691	8.72	.1564E-04
55	1113.00	2.0160	2.0155	0.999660	8.86	.1629E-04
56	1115.00	2.0460	2.0471	0.999082	9.00	.1682E-04
57	1117.00	2.0830	2.0815	0.998599	9.15	.1703E-04
58	1119.00	2.1130	2.1160	0.998529	9.30	.1746E-04
59	1121.00	2.1560	2.1515	0.998300	9.47	.1825E-04
60	1122.50	2.1760	2.1780	0.997823	9.60	.1945E-04
61	1124.00	2.2060	2.2086	0.997339	9.74	.2004E-04
62	1125.50	2.2380	2.2385	0.997460	9.89	.2050E-04
63	1127.00	2.2760	2.2725	0.998893	10.07	.2108E-04
64	1129.00	2.3130	2.3148	0.998930	10.29	.2061E-04
65	1130.00	2.3360	2.3345	0.995654	10.39	.2212E-04
66	1131.00	2.3530	2.3553	0.997940	10.51	.2300E-04
67	1132.00	2.3760	2.3791	0.997384	10.64	.2407E-04
68	1133.00	2.4080	2.4037	0.997665	10.78	.2561E-04
69	1134.00	2.4310	2.4310	0.998650	10.94	.2739E-04
70	1135.00	2.4560	2.4584	0.998531	11.11	.2886E-04
71	1136.00	2.4880	2.4869	0.999605	11.29	.3000E-04
72	1137.00	2.5180	2.5186	0.999759	11.49	.3218E-04
73	1138.00	2.5530	2.5497	0.995679	11.70	.3671E-04
74	1139.00	2.5860	2.5910	0.982727	11.98	.3625E-04
75	1140.00	2.6230	2.6288	0.983859	12.25	.3757E-04
76	1141.00	2.6860	2.6673	0.979011	12.54	.3964E-04
77	1142.00	2.6910	2.7079	0.977235	12.87	.4105E-04
78	1142.80	2.7360	2.7402	0.972650	13.13	.4482E-04
79	1143.00	2.7560	2.7443	0.981183	13.17	.4432E-04
80	1144.00	2.7930	2.8002	0.994164	13.66	.5174E-04
81	1144.40	2.8210	2.8186	0.994581	13.84	.5318E-04
82	1144.80	2.8410	2.8394	0.997718	14.04	.5665E-04
83	1145.20	2.8630	2.8636	0.997765	14.28	.6196E-04
84	1145.60	2.8860	2.8882	0.998813	14.53	.6366E-04
85	1146.00	2.9160	2.9142	0.998254	14.81	.7071E-04
86	1146.40	2.9460	2.9435	0.998159	15.14	.7841E-04
87	1146.80	2.9710	2.9759	0.997914	15.53	.8821E-04
88	1147.20	3.0130	3.0125	0.997132	15.99	.9342E-04
89	1147.40	3.0330	3.0321	0.996991	16.25	.9629E-04
90	1147.60	3.0560	3.0539	0.999481	16.56	.9991E-04
91	1148.00	3.0910	3.0924	0.998147	17.13	.1020E-03
92	1148.20	3.1130	3.1119	0.997937	17.43	.1098E-03
93	1148.40	3.1310	3.1334	0.996230	17.79	.1262E-03
94	1148.60	3.1580	3.1588	0.997183	18.23	.1418E-03
95	1148.80	3.1860	3.1878	0.987014	18.77	.1892E-03
96	1148.90	3.2110	3.2040	0.978770	19.09	.2419E-03
97	1149.10	3.2410				
98	1149.20	3.2910				
99	1149.30	3.3480				

* - DATA VIOLATES SIZE REQUIREMENTS



Material:	2091-T851 Plate
Age:	335°F - 16 hrs
Environment:	Lab air, Room temperature
Orientation:	L-T
Stress Ratio:	0.1
Frequency:	5 Hz

Figure A19 Fatigue Crack Growth Rate Data for 2091-T8X 0.42" Plate (L-T orientation). General Dynamics TX.

TABLE A48

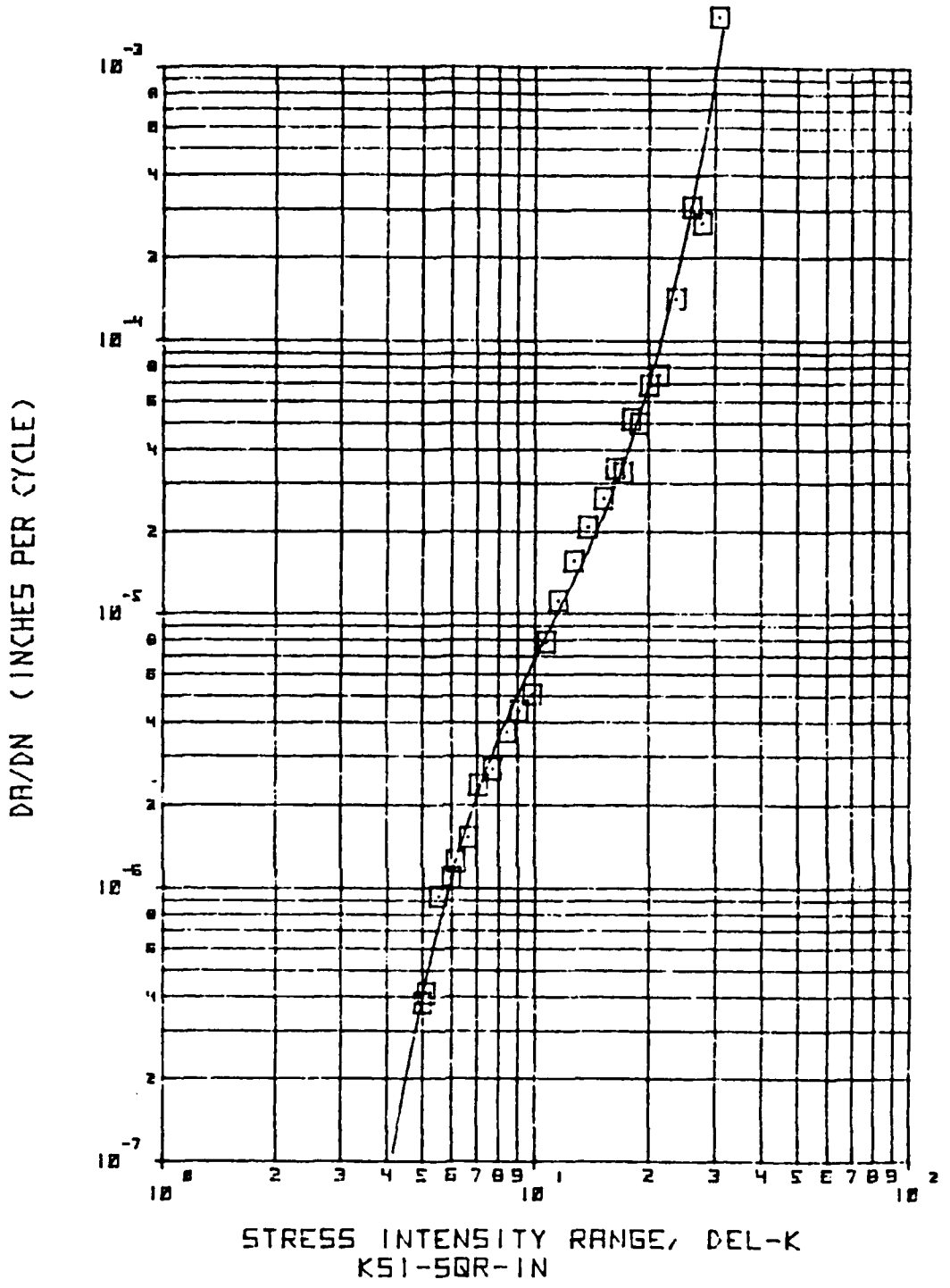
Fatigue Crack Growth Rate Data Associated with Figure A19

COMPACT TENSION AT H/W=0.486
P34
2091,T335 LT ORIENTATION
LAB AIR,RT

GENERAL DYNAMICS
FORT WORTH DIVISION
APR 08,1987

180 CPM
R= 0.1 B= 0.4195 W= 2.5605

NO. OF PTS.	TOTAL CYCLES	AVG. CRACK LENGTH (IN)	DELTA CRACK LENGTH (IN)	LSQ FIT DA/DN (IN/CYC)	CORR. COEFF.	AVG. MAX. LOAD (LBS)	AVG. DEL-K (KSI-SQRT(IN))
9	43358	0.8294	0.0585	1.27E-06	0.984	807	7.51
10	57324	0.8708	0.0505	1.02E-06	0.973	703	6.76
11	35690	0.9239	0.0614	1.87E-06	0.978	729	7.33
10	18067	0.9763	0.0484	2.81E-06	0.997	755	7.94
11	19039	1.0200	0.0576	3.16E-06	0.997	782	8.54
9	13665	1.0683	0.0457	3.41E-06	0.995	807	9.20
6	6680	1.1134	0.0385	5.49E-06	0.992	831	9.85
10	8910	1.1573	0.0516	5.59E-06	0.995	856	10.55
8	4212	1.1837	0.0375	8.36E-06	0.985	882	11.14
7	5913	1.2279	0.0460	7.95E-06	0.998	882	11.60
7	3190	1.2393	0.0396	1.19E-05	0.998	909	12.08
5	3095	1.2801	0.0409	1.39E-05	0.987	909	12.57
13	4622	1.3163	0.0607	1.48E-05	0.995	935	13.41
8	1962	1.3518	0.0391	2.05E-05	0.995	958	14.26
4	1456	1.3837	0.0296	1.98E-05	0.980	958	14.77
7	1746	1.3915	0.0367	2.12E-05	0.997	984	15.32
6	1587	1.4359	0.0455	2.68E-05	0.994	984	16.14
5	807	1.4514	0.0293	3.47E-05	0.979	1011	16.90
6	1137	1.4858	0.0369	3.18E-05	0.999	1010	17.66
4	694	1.4990	0.0304	3.82E-05	0.993	1030	18.33
6	885	1.5372	0.0419	4.69E-05	0.997	1031	19.36
10	742	1.5703	0.0611	7.80E-05	0.991	1057	20.85
8	325	1.6143	0.0469	1.33E-04	0.991	1083	22.89
7	287	1.6588	0.0396	1.44E-04	0.998	1083	24.67
7	107	1.6664	0.0335	2.87E-04	0.991	1110	25.62
7	114	1.7043	0.0376	3.25E-04	0.996	1109	27.44
6	94	1.7346	0.0411	3.88E-04	0.957	1134	29.71
7	110	1.7796	0.0560	4.93E-04	0.988	1135	32.50
3	22	1.7961	0.0492	2.23E-03	0.997	1158	34.31
2	10	1.8430	0.0439	4.39E-03	1.000	1158	37.87



Material:	2091-T851 Plate
Age:	335°F - 16 hrs
Environment:	Lab air, Room temperature
Orientation:	T-L
Stress Ratio:	0.1
Frequency:	5 Hz

Figure A20 Fatigue Crack Growth Rate Data for 2091-T8X 0.42" Plate (T-L orientation). General Dynamics TX.

TABLE A49

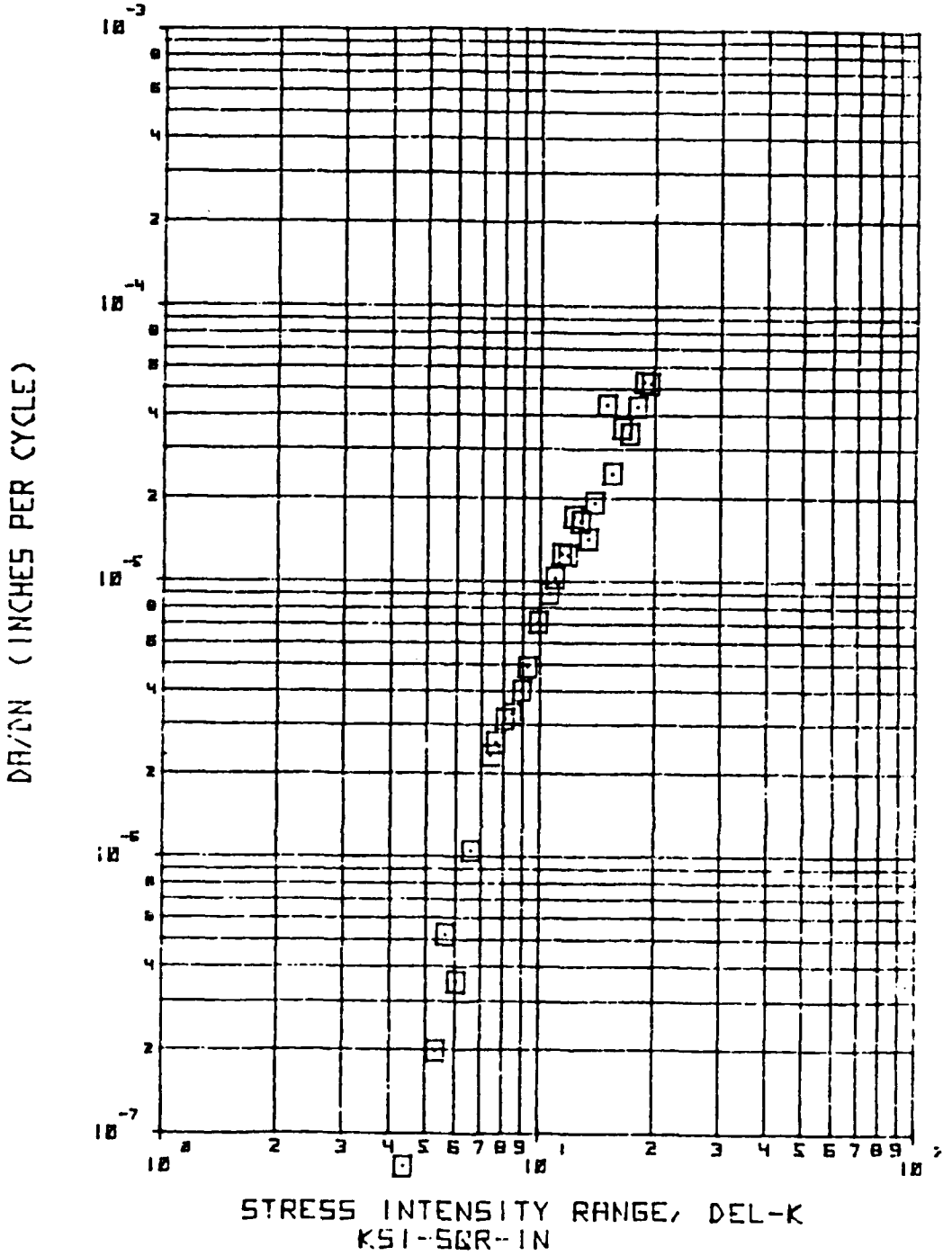
Fatigue Crack Growth Rate Data Associated with Figure A20

COMPACT TENSION AT H/W=0.486
P35
2091,T335 TL ORIENTATION
LAB AIR,RT

GENERAL DYNAMICS
FORT WORTH DIVISION
APR 16,1987

180 CPM
R= 0.1 B= 0.4185 W= 2.56

NO. OF PTS.	TOTAL CYCLES	AVG. CRACK LENGTH (IN)	DELTA CRACK LENGTH (IN)	LSQ FIT DA/DN (IN/CYC)	CORR. COEFF.	AVG. MAX. LOAD (LBS)	AVG. DEL-K (KSI-SQRT
13	76003	0.7876	0.0270	3.82E-07	0.962	555	5.00
5	68494	0.8190	0.0268	4.15E-07	0.992	554	5.13
10	56211	0.8516	0.0527	9.35E-07	0.967	581	5.52
9	36607	0.8934	0.0351	1.09E-06	0.984	607	5.97
5	22016	0.9311	0.0275	1.26E-06	0.996	607	6.16
6	21234	0.9836	0.0332	1.53E-06	0.990	627	6.65
13	35436	1.0096	0.0734	2.36E-06	0.984	652	7.08
13	21419	1.0664	0.0528	2.69E-06	0.990	675	7.70
8	12207	1.1278	0.0460	3.69E-06	0.987	701	8.43
10	12369	1.1699	0.0566	4.41E-06	0.996	727	9.09
9	10471	1.2200	0.0541	5.07E-06	0.993	754	9.87
8	7161	1.2736	0.0592	7.88E-06	0.997	779	10.74
8	5518	1.3168	0.0622	1.12E-05	0.999	804	11.58
10	3442	1.3753	0.0585	1.57E-05	0.983	828	12.69
13	2648	1.4216	0.0604	2.08E-05	0.989	854	13.81
9	2282	1.4718	0.0620	2.66E-05	0.998	881	15.18
6	1020	1.5047	0.0369	3.43E-05	0.994	906	16.30
4	831	1.5384	0.0275	3.29E-05	1.000	906	17.10
5	556	1.5571	0.0298	5.19E-05	0.992	933	18.08
4	595	1.5870	0.0302	5.00E-05	0.998	934	18.96
5	481	1.6090	0.0329	6.88E-05	1.000	957	20.12
5	535	1.6463	0.0406	7.51E-05	0.998	956	21.40
8	491	1.6879	0.0715	1.42E-04	0.998	982	23.68
4	107	1.7258	0.0325	3.08E-04	0.999	1008	26.05
5	135	1.7579	0.0359	2.68E-04	1.000	1008	27.72
3	30	1.8003	0.0442	1.54E-03	0.979	1030	30.86
2	15	1.8349	0.0358	2.44E-03	1.000	1029	33.18



Material:	2091-T851 Plate
Age:	335°F - 16 hrs
Environment:	Lab air, Room temperature
Orientation:	T-L
Stress Ratio:	0.1
Frequency:	5 Hz

Figure A21 Fatigue Crack Growth Rate Data for 2091-T8X 0.42" Plate (T-L orientation). General Dynamics TX.

TABLE A50

Fatigue Crack Growth Rate Data Associated with Figure A21

COMPACT TENSION AT H/W=0.486
P36
2091,T335 TL ORIENTATION
LAB AIR,RT
335F FOR 16HRS
180 CPM
R= 0.1 B= 0.4203 W= 2.5515

GENERAL DYNAMICS
FORT WORTH DIVISION
MAR 11,1987

NO. OF PTS.	TOTAL CYCLES	AVG. CRACK LENGTH (IN)	DELTA CRACK LENGTH (IN)	LSQ FIT DA/DN (IN/CYC)	CORR. COEFF.	AVG. MAX. LOAD (LBS)	AVG. DEL-K (KSI-SQRT)
8	418184	0.8105	0.0377	7.60E-08	0.974	476	4.37
10	244850	0.8655	0.0598	1.98E-07	0.957	555	5.33
7	80247	0.8793	0.0389	5.22E-07	0.980	581	5.64
12	193294	0.9094	0.0498	3.53E-07	0.955	607	6.05
8	52395	0.9706	0.0494	1.05E-06	0.980	628	6.59
6	15098	1.0193	0.0331	2.32E-06	0.961	677	7.41
5	12198	1.0568	0.0301	2.59E-06	0.992	677	7.66
9	13313	1.0734	0.0365	3.15E-06	0.978	704	8.08
6	12737	1.1209	0.0405	3.29E-06	0.998	703	8.42
7	7330	1.1483	-0.0278	4.01E-06	0.993	730	8.95
6	7924	1.1868	0.0380	4.90E-06	0.999	730	9.27
9	7718	1.2211	0.0565	7.10E-06	0.999	756	9.93
7	3334	1.2546	0.0319	9.07E-06	0.989	783	10.60
5	2900	1.2874	0.0306	1.03E-05	0.997	782	10.94
6	2699	1.2965	0.0378	1.26E-05	0.986	808	11.41
4	2410	1.3326	0.0293	1.25E-05	0.998	808	11.84
5	1131	1.3392	0.0219	1.72E-05	0.971	831	12.27
6	3105	1.3768	0.0510	1.65E-05	1.000	832	12.81
6	1492	1.3916	0.0226	1.43E-05	0.972	858	13.43
5	1701	1.4222	0.0333	1.93E-05	0.997	858	13.92
5	482	1.4578	0.0235	4.38E-05	0.923	884	14.99
5	1327	1.4835	0.0331	2.46E-05	0.997	883	15.50
6	683	1.5043	0.0275	3.60E-05	0.961	910	16.43
6	1020	1.5362	0.0354	3.43E-05	0.999	910	17.19
7	503	1.5488	0.0274	4.31E-05	0.928	937	18.03
5	465	1.5749	0.0239	5.29E-05	0.997	936	18.75
4	572	1.5994	0.0305	5.23E-05	0.988	936	19.49

APPENDIX B

PECHINEY 2091-T3 AND 2091-T8X (0.063" X 79" X 39")

INTRODUCTION

The Pechiney 2091-T3 0.063-inch sheet was received the second quarter of 1986. Three participants heat treated the 2091-T3 to a T8X temper. Grumman Aircraft Systems and Northrop Corporation achieved the T8 condition by aging the 2091 sheet at 275°F for 12 hours (recommended by the producer of this alloy). General Dynamics Fort Worth Division aged the 2091 sheet at 335°F for 32 hours achieving the T81 condition.

TESTING

Basic mechanical properties (tension, compression, bearing, etc.) were tested according to ASTM standards, unless otherwise specified.

Constant amplitude fatigue crack growth tests were conducted according to ASTM E647 standard. The growth rate a-N data that was generated by the participants (Grumman, McDonnell Aircraft Co., and Northrop) were reduced using a seven-point incremental polynomial method. This involves fitting a second-order polynomial (parabola) to sets of seven successive data points. The data are also checked against size requirements per ASTM E647, Section 7.2. General Dynamics, TX performed constant amplitude fatigue crack growth tests using a K-increasing (load increasing) method.

2091-T3 SHEET
(0.063"x79"x79")

TABLE B1

TENSILE RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMP (DEGREES F)	ORIENTATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
BOEING	RT	LONG	57.0	41.3	13.0		
			58.1	41.2	20.0		
			58.0	41.2	22.0		
LTV	RT	LONG	58.8		21.5		
			58.6	39.0	21.0		10.7
			58.2	39.4	19.5		11.0
GENERAL DYNAMICS, CALIF.	RT	LONG	56.7	41.1	20.0		10.7
			55.9	40.3	20.0		10.7
			56.5	41.7	18.5		10.7
NORTHROP			58.5	42.3	16.9		
			58.9	42.1	16.9		
			59.0	42.5	16.9		
MCAIR	RT	LONG	57.5	42.6	19.0		12.0
			57.0	42.4	16.0		[illegible].1
			57.5	42.4	23.0		[illegible].2
MARTIN MARIETTA, LOUISIANA	RT	LONG	56.1	39.4	18.0	27.0	
			57.6	40.8	20.0	21.0	
			59.2	42.5	22.0	25.0	
		AVERAGE	57.7	41.3	19.1	24.3	11.3
	STANDARD DEVIATION		1.0	1.2	2.5	3.1	0.7

TABLE B2

TENSILE RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
BOEING	RT	L TRANS	60.8	41.5	16.0		
			61.4	41.5	17.0		
			60.8	41.6	16.0		
NORTHROP	RT	L TRANS	62.0	41.9	17.0		
			62.7	41.6	16.8		
			62.0	42.0	17.1		
LTV	RT	L TRANS	61.7	40.0	17.0		10.7
			61.6	39.9	18.5		10.6
			61.9	39.3	16.5		11.0
GENERAL DYNAMICS, CALIF.	RT	L TRANS	60.0	41.3	22.0		10.9
			60.2	41.2	21.0		10.9
			59.7	41.4	20.0		10.9
MCAIR	RT	L TRANS	62.0	42.2	17.0		12.0
			60.5	42.7	17.0		12.0
			60.5	41.9	18.0		12.1
MARTIN MARIETTA, LOUISIANA	RT	L TRANS	60.8	41.2	17.0	27.0	
			60.5	40.8	16.0	21.0	
			60.3	40.9	16.0	24.0	
		AVERAGE	61.1	41.3	17.6	24.0	11.2
	STANDARD DEVIATION		0.9	0.9	1.8	3.0	0.6

TABLE B3

COMPRESSION RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
BOEING	RT	LONG	39.4	
			39.6	
			39.9	
LTV	RT	LONG	41.4	10.6
			41.4	10.6
GENERAL DYNAMICS, CALIF.	RT	LONG	38.7	11.7
			38.9	12.0
			39.1	12.0
		AVERAGE	39.8	11.4
		STANDARD DEVIATION	1.0	0.7

TABLE B4

COMPRESSION RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (KSI)
BOEING	RT	L TRANS	44.6	
			44.7	
			44.5	
LTV	RT	L TRANS	45.9	
			45.2	
			45.3	
GENERAL DYNAMICS, CALIF.	RT	L TRANS	42.7	11.8
			44.3	11.5
		AVERAGE	44.7	11.7
		STANDARD DEVIATION	1.0	0.2

TABLE B5

PUNCH SHEAR RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
BOEING	S TRANS	36.0
		36.5
		36.0
	AVERAGE	36.2
	STANDARD DEVIATION	0.3

TABLE B6

SLOTTED SHEAR RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
BOEING	LONG	39.8
		39.0
		36.9
LTV	LONG	38.3
		38.6
		37.9
MCAIR	LONG	38.1
		37.9
		38.2
	AVERAGE	38.3
	STANDARD DEVIATION	0.8

TABLE B7

SLOTTED SHEAR RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 39" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
BOEING	T - L	36.8
		40.1
		36.4
LTV	T - L	40.0
		40.5
		40.5
MCAIR	T - L	39.2
		37.9
		39.0
	AVERAGE	38.9
	STANDARD DEVIATION	1.5

TABLE B8

BEARING RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING	LONG	1.5	88.9	61.4
			90.2	63.0
			90.3	63.5
LTV	LONG	1.5	90.4	58.9
			88.5	61.2
			89.3	61.4
GENERAL DYNAMICS, CALIF.	LONG	1.5	88.6	66.6
			88.1	64.0
			90.0	64.0
		AVERAGE	89.4	62.7
		STANDARD DEVIATION	0.9	2.2

TABLE B9

BEARING RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING	L TRANS	1.5	92.9	62.6
			93.1	63.3
			93.1	63.3
LTV	L TRANS	1.5	91.0	60.5
			92.1	59.7
			92.2	61.8
GENERAL DYNAMICS, CALIF.	L TRANS	1.5	90.3	65.7
			88.5	62.3
			87.9	64.0
		AVERAGE	91.2	62.6
		STANDARD DEVIATION	2.0	1.8

TABLE B10

BEARING RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING	LONG	2.0	115.2	75.6
			115.8	76.1
			115.3	76.2
LTV	LONG	2.0	111.6	77.3
			111.0	76.4
			112.5	76.9
GENERAL DYNAMICS, CALIF.	LONG	2.0	115.6	76.8
			114.3	73.2
MCAIR	LONG	2.0		73.5
				73.9
		AVERAGE	113.9	75.6
		STANDARD DEVIATION	1.9	

TABLE B11

BEARING RESULTS FOR PECHINEY

2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING	L TRANS	2.0	118.8	76.5
			115.2	75.4
LTV	L TRANS	2.0	111.1	75.9
			114.1	78.8
			116.0	75.1
GENERAL DYNAMICS, CALIF.	L TRANS	2.0	120.6	76.8
			115.9	81.8
			111.7	80.3
MCAIR	L TRANS	2.0		76.5
				72.7
		AVERAGE	115.4	77.0
		STANDARD DEVIATION	3.2	2.7

TABLE B12

General Dynamics, CA

ASTM E561 R Curve CCT Al-Li B-5-LT-1

W = 3.994 in
B = 0.0644 in
a = 1.255 in
a/2 = 0.6275 in

Fty = 41.10 ksi
Pmax = 7540 lb

a eff	Loads 5000	7540	10000
0.6	28	43	57
0.6	29	44	58
0.7	30	45	59
0.7	30	46	61
0.7	31	47	62
0.7	32	48	64
0.8	33	49	65
0.8	33	51	67
0.8	34	52	69
0.8	35	53	70
0.9	36	54	72
0.9	37	55	73
0.9	38	57	75
0.9	38	58	77
1.0	39	59	78
1.0	40	60	80
1.0	41	62	82
1.0	42	63	84
1.1	43	65	86
1.1	44	66	88
1.1	45	68	90

Load	a (half)	a plastic	a eff	K
0	0.6275	0.0000	0.6275	0
200	0.7225	0.0002	0.7227	1
600	0.7225	0.0014	0.7239	4
1000	0.7225	0.0038	0.7263	6
1400	0.7225	0.0075	0.7300	9
1800	0.7225	0.0124	0.7349	12
2200	0.7225	0.0186	0.7411	14
2600	0.7225	0.0259	0.7484	17
2800	0.7250	0.0302	0.7552	18
3200	0.7250	0.0395	0.7645	21
3600	0.7250	0.0499	0.7749	24
4000	0.7275	0.0619	0.7894	27
4400	0.7275	0.0750	0.8025	30
4600	0.7275	0.0819	0.8094	32
4800	0.7300	0.0896	0.8196	33
5200	0.7300	0.1052	0.8352	37
5600	0.7300	0.1220	0.8520	40
5800	0.7300	0.1309	0.8609	42
6000	0.7450	0.1440	0.8890	45
6200	0.7450	0.1538	0.8988	46
6400	0.7600	0.1685	0.9285	49
6800	0.7600	0.1902	0.9502	53
7000	0.7700	0.2053	0.9753	56
7200	0.7700	0.2172	0.9872	58
7400	0.7850	0.2359	1.0209	62

$K_c = 61.8 \text{ Ksi}\sqrt{\text{in}}$

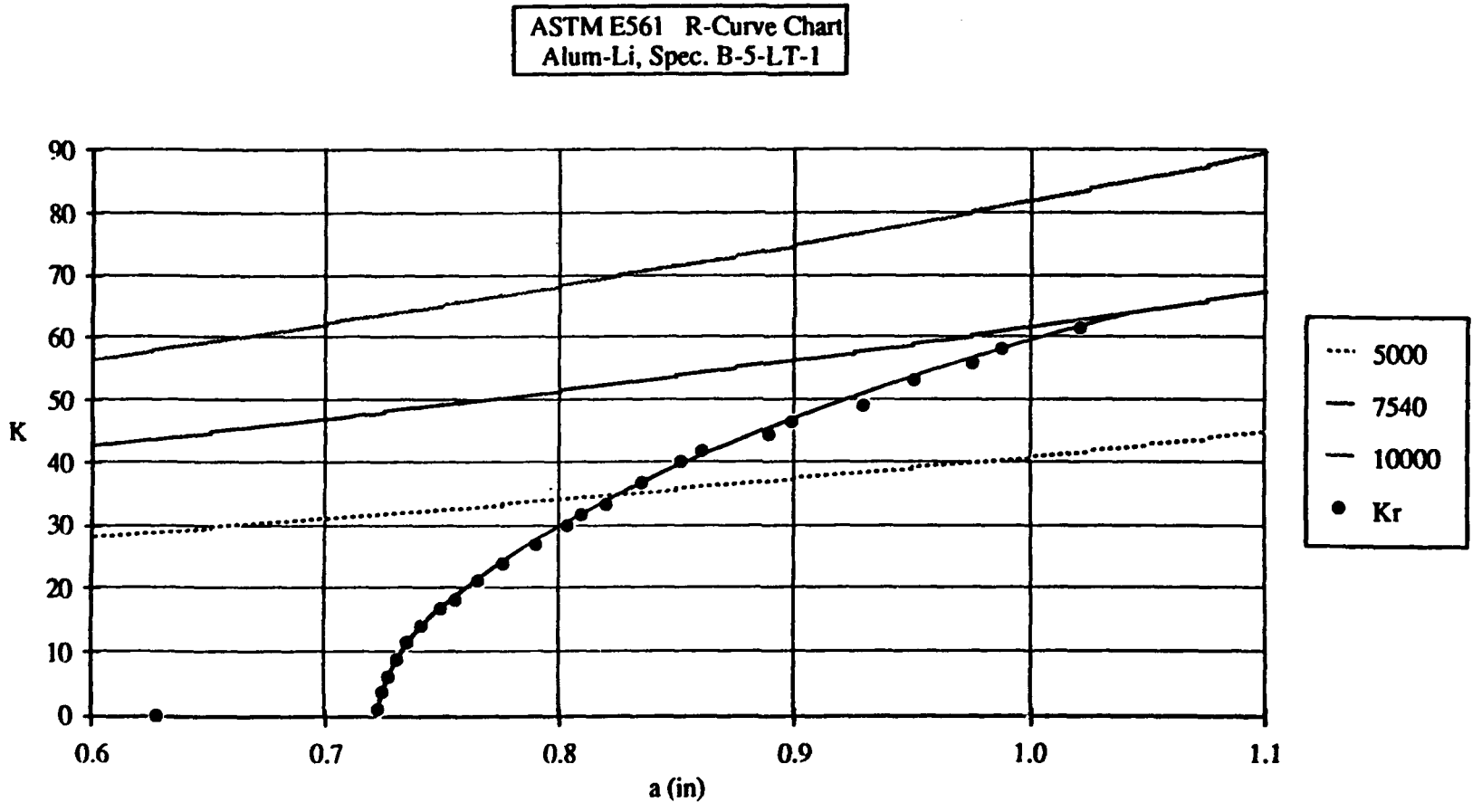


Figure B1 R-Curve Results for 2091-T3 0.063" Sheet (LT) General Dynamics, CA.

TABLE B13

General Dynamics, CA

ASTM E561 R Curve CCT Al-Li B-5-LT-2

W = 3.995 in
B = 0.0647 in
a = 1.255 in
a/2 = 0.6275 in

Fty = 41.10 ksi
Pmax = 7250 lb

a eff	Loads 5000	7250	10000
0.6	28	41	56
0.6	29	42	58
0.7	30	43	59
0.7	30	44	61
0.7	31	45	62
0.7	32	46	64
0.8	33	47	65
0.8	33	48	67
0.8	34	49	68
0.8	35	51	70
0.9	36	52	71
0.9	36	53	73
0.9	37	54	75
0.9	38	55	76
1.0	39	57	78
1.0	40	58	80
1.0	41	59	82
1.0	42	60	83
1.1	43	62	85
1.1	44	63	87
1.1	45	65	89

Load	a (half)	a plastic	a eff	K
0	0.6275	0.0000	0.6275	0
200	0.7250	0.0002	0.7252	1
600	0.7250	0.0014	0.7264	4
1000	0.7250	0.0038	0.7288	6
1400	0.7250	0.0075	0.7325	9
1800	0.7250	0.0124	0.7374	12
2200	0.7250	0.0185	0.7435	14
2600	0.7250	0.0258	0.7508	17
2800	0.7250	0.0299	0.7549	18
3200	0.7250	0.0391	0.7641	21
3600	0.7250	0.0494	0.7744	24
4000	0.7275	0.0613	0.7888	27
4200	0.7275	0.0676	0.7951	29
4400	0.7300	0.0746	0.8046	30
4600	0.7300	0.0815	0.8115	32
4800	0.7300	0.0887	0.8187	33
5200	0.7300	0.1041	0.8341	37
5600	0.7300	0.1208	0.8508	40
5800	0.7300	0.1296	0.8596	42
6000	0.7300	0.1387	0.8687	44
6200	0.7325	0.1488	0.8813	46
6400	0.7325	0.1585	0.8910	47
6800	0.7375	0.1806	0.9181	52
7000	0.7450	0.1941	0.9391	54
7200	0.7550	0.2092	0.9642	57

$K_c = 56.9 \text{ Ksi } \sqrt{in}$

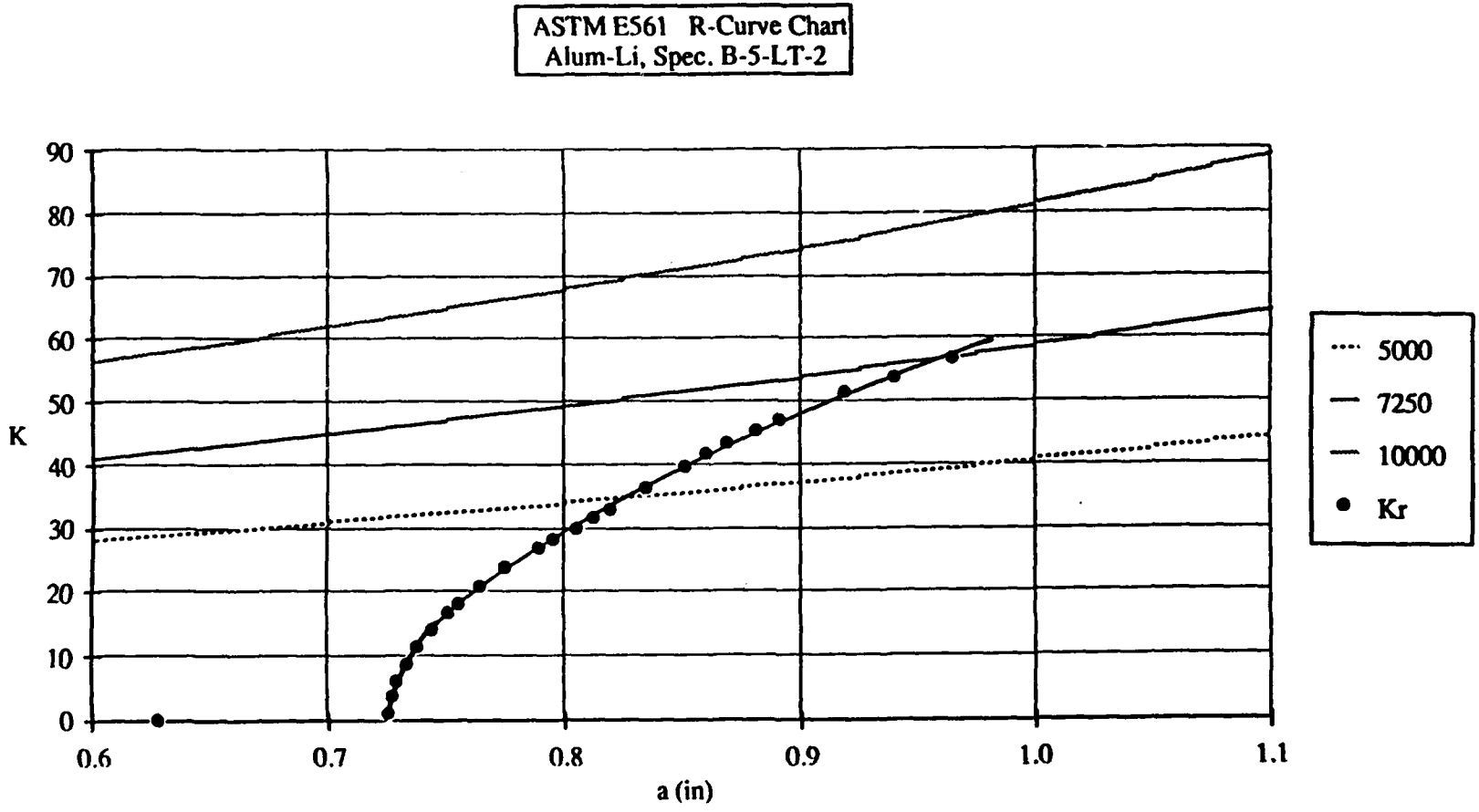


Figure B2 R-Curve Results for 2091-T3 0.063" Sheet (LT). General Dynamics, CA.

TABLE B14

General Dynamics, CA

ASTM E561 R Curve CCT Al-Li B-5-LT-3

W = 3.992 in
B = 0.0642 in
a = 1.2600 in
a/2 = 0.6300 in

Fty = 41.10 ksi
Pmax = 5875 lb

	Loads		
a eff	4000	5875	8000
0.6	23	33	45
0.6	23	34	47
0.7	24	35	48
0.7	24	36	49
0.7	25	37	50
0.7	26	38	51
0.8	26	39	53
0.8	27	40	54
0.8	28	40	55
0.8	28	41	56
0.9	29	42	58
0.9	29	43	59
0.9	30	44	60
0.9	31	45	62
1.0	31	46	63
1.0	32	47	64
1.0	33	48	66

Load	a (half)	a plastic	a eff	K
0	0.6300	0.0000	0.6300	0
200	0.7275	0.0002	0.7277	1
600	0.7275	0.0014	0.7289	4
1000	0.7275	0.0039	0.7314	6
1400	0.7275	0.0076	0.7351	9
1800	0.7275	0.0126	0.7401	12
2000	0.7275	0.0156	0.7431	13
2200	0.7275	0.0189	0.7464	14
2600	0.7275	0.0264	0.7539	17
3000	0.7275	0.0351	0.7626	20
3400	0.7275	0.0451	0.7726	23
3800	0.7275	0.0563	0.7838	26
4200	0.7275	0.0688	0.7963	29
4400	0.7275	0.0755	0.8030	30
4600	0.7275	0.0825	0.8100	32
4800	0.7275	0.0899	0.8174	34
5000	0.7275	0.0975	0.8250	35
5200	0.7275	0.1055	0.8330	37
5400	0.7275	0.1137	0.8412	39
5600	0.7275	0.1223	0.8498	40
5800	0.7275	0.1312	0.8587	42

~~Kc = 42.1 Ksi $\sqrt{in}$~~ Specimen failed in doubler region

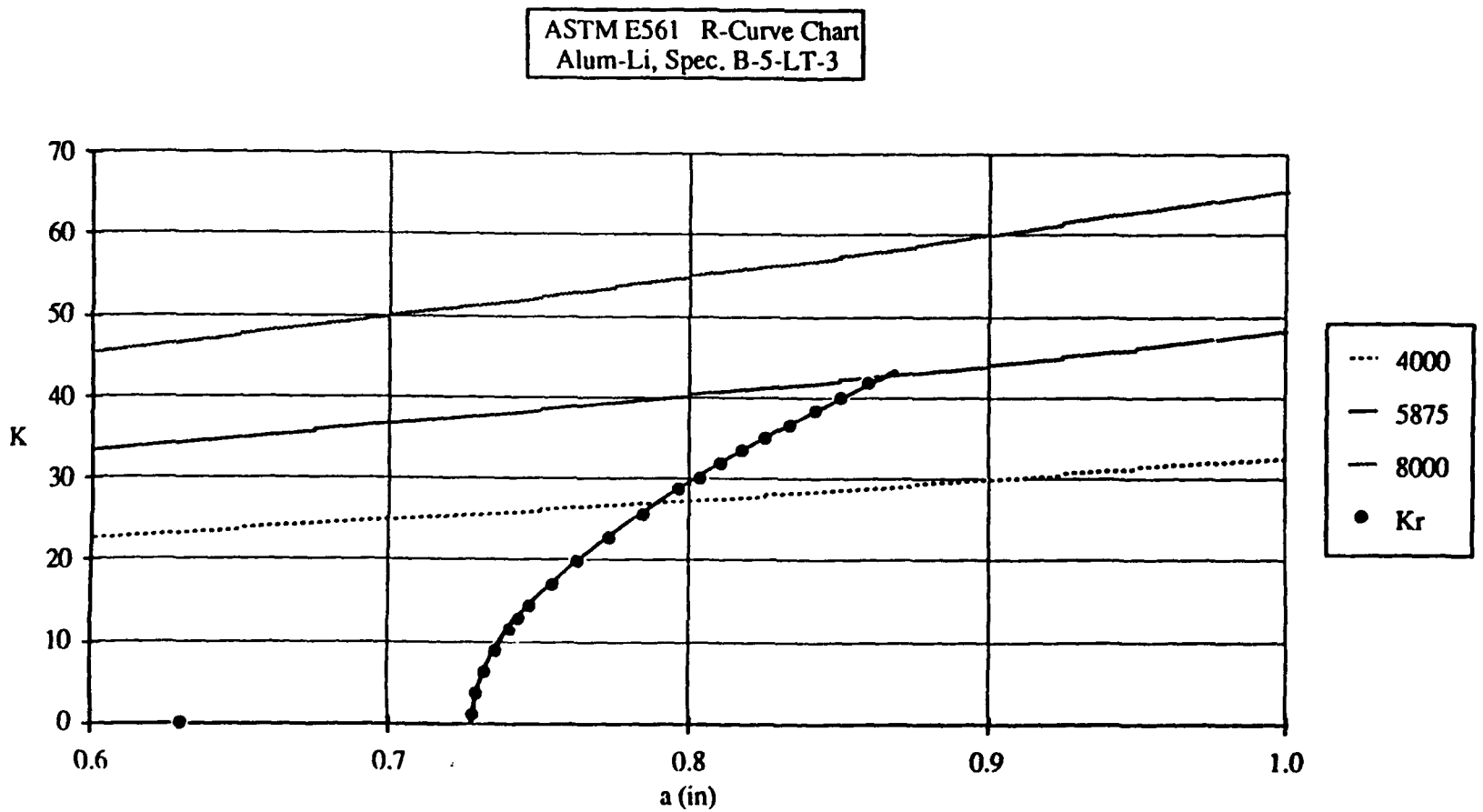


Figure B3 R-Curve Results for 2091-T3 0.063" Sheet (LT). General Dynamics, CA.

TABLE B15

General Dynamics, CA

ASTM E561 R Curve CCT Al-Li B-5-TL-1

W = 3.995 in Fty = 41.10 ksi
B = 0.0649 in Pmax = 7290 lb
a = 1.25 in
a/2 = 0.625 in

a eff	Loads 5000	7290	10000
0.6	28	41	56
0.6	29	42	58
0.7	30	43	59
0.7	30	44	60
0.7	31	45	62
0.7	32	46	63
0.8	32	47	65
0.8	33	48	66
0.8	34	50	68
0.8	35	51	70
0.9	36	52	71
0.9	36	53	73
0.9	37	54	74
0.9	38	55	76
1.0	39	57	78
1.0	40	58	80
1.0	41	59	81
1.0	42	61	83
1.1	43	62	85
1.1	44	63	87
1.1	45	65	89

Load	a (half)	a plastic	a eff	K
0	0.6250	0.0000	0.6250	0
200	0.7400	0.0002	0.7402	1
600	0.7400	0.0014	0.7414	4
1000	0.7400	0.0039	0.7439	6
1400	0.7400	0.0076	0.7476	9
1600	0.7425	0.0100	0.7525	10
2000	0.7425	0.0157	0.7582	13
2400	0.7425	0.0226	0.7651	16
2800	0.7425	0.0307	0.7732	19
3200	0.7425	0.0401	0.7826	21
3600	0.7425	0.0508	0.7933	24
4000	0.7425	0.0627	0.8052	27
4400	0.7425	0.0759	0.8184	30
4600	0.7425	0.0829	0.8254	32
4800	0.7450	0.0907	0.8357	34
5000	0.7475	0.0989	0.8464	35
5200	0.7525	0.1079	0.8604	37
5600	0.7525	0.1252	0.8777	41
6000	0.7525	0.1437	0.8962	44
6200	0.7550	0.1542	0.9092	47
6400	0.7575	0.1650	0.9225	49
6600	0.7575	0.1755	0.9330	51
6800	0.7625	0.1881	0.9506	53
7000	0.7625	0.1993	0.9618	55
7200	0.7950	0.2238	1.0188	60

$K_c = 59.6\ \text{Ksi}\sqrt{\text{in}}$

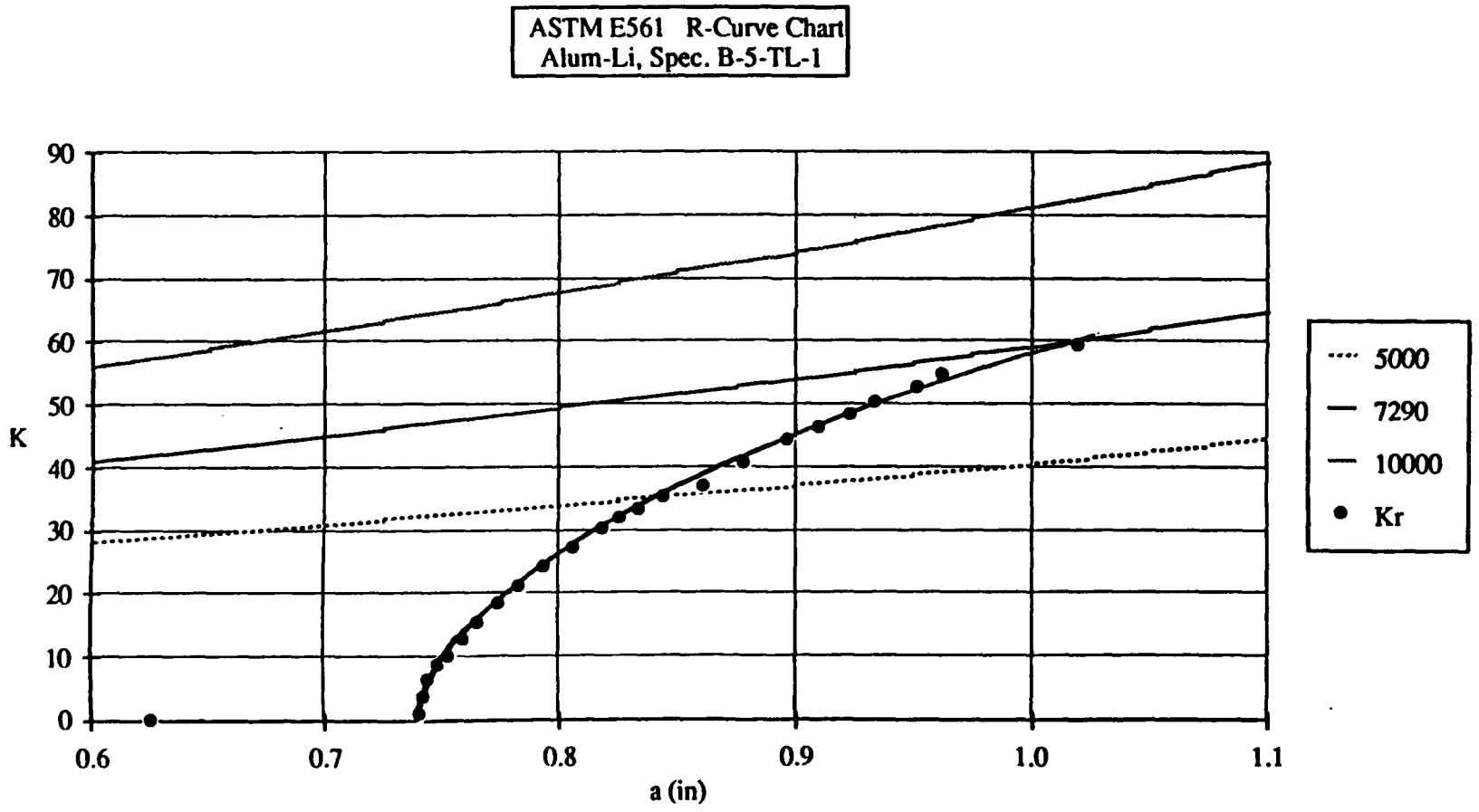


Figure B4 R-Curve Results for 2091-T3 0.063" Sheet (TL). General Dynamics, CA.

TABLE B16

General Dynamics, CA

ASTM E561 R Curve CCT Al-Li B-5-TL-2

W = 3.992 in
B = 0.0646 in
a = 1.2550 in
a/2 = 0.6275 in

Fty = 41.10 ksi
Pmax = 7450 lb

a eff	Loads 5000	7450	10000
0.6	28	42	56
0.6	29	43	58
0.7	30	44	59
0.7	30	45	61
0.7	31	46	62
0.7	32	48	64
0.8	33	49	65
0.8	33	50	67
0.8	34	51	68
0.8	35	52	70
0.9	36	53	72
0.9	37	55	73
0.9	37	56	75
0.9	38	57	77
1.0	39	58	78
1.0	40	60	80
1.0	41	61	82
1.0	42	62	84
1.1	43	64	86
1.1	44	65	88
1.1	45	67	90

Load	a (half)	a plastic	a eff	K
0	0.6275	0.0000	0.6275	0
200	0.7275	0.0002	0.7277	1
400	0.7275	0.0006	0.7281	3
600	0.7325	0.0014	0.7339	4
1000	0.7325	0.0039	0.7364	6
1400	0.7325	0.0076	0.7401	9
1800	0.7325	0.0126	0.7451	12
2200	0.7325	0.0188	0.7513	14
2600	0.7325	0.0263	0.7588	17
3000	0.7325	0.0350	0.7675	20
3400	0.7325	0.0450	0.7775	23
3600	0.7425	0.0513	0.7938	24
3800	0.7425	0.0572	0.7997	26
4000	0.7450	0.0637	0.8087	28
4200	0.7450	0.0702	0.8152	29
4400	0.7525	0.0781	0.8306	31
4600	0.7525	0.0854	0.8379	33
4800	0.7550	0.0934	0.8484	34
5400	0.7550	0.1183	0.8733	39
5600	0.7575	0.1278	0.8853	41
6000	0.7575	0.1467	0.9042	45
6200	0.7600	0.1573	0.9173	47
6400	0.7600	0.1677	0.9277	49
6600	0.7675	0.1808	0.9483	52
6800	0.7725	0.1937	0.9662	54
7000	0.7800	0.2081	0.9881	57
7200	0.7875	0.2232	1.0107	59
7400	0.8025	0.2423	1.0448	63

$K_c = 63.0 \text{ Ksi}\sqrt{\text{in}}$

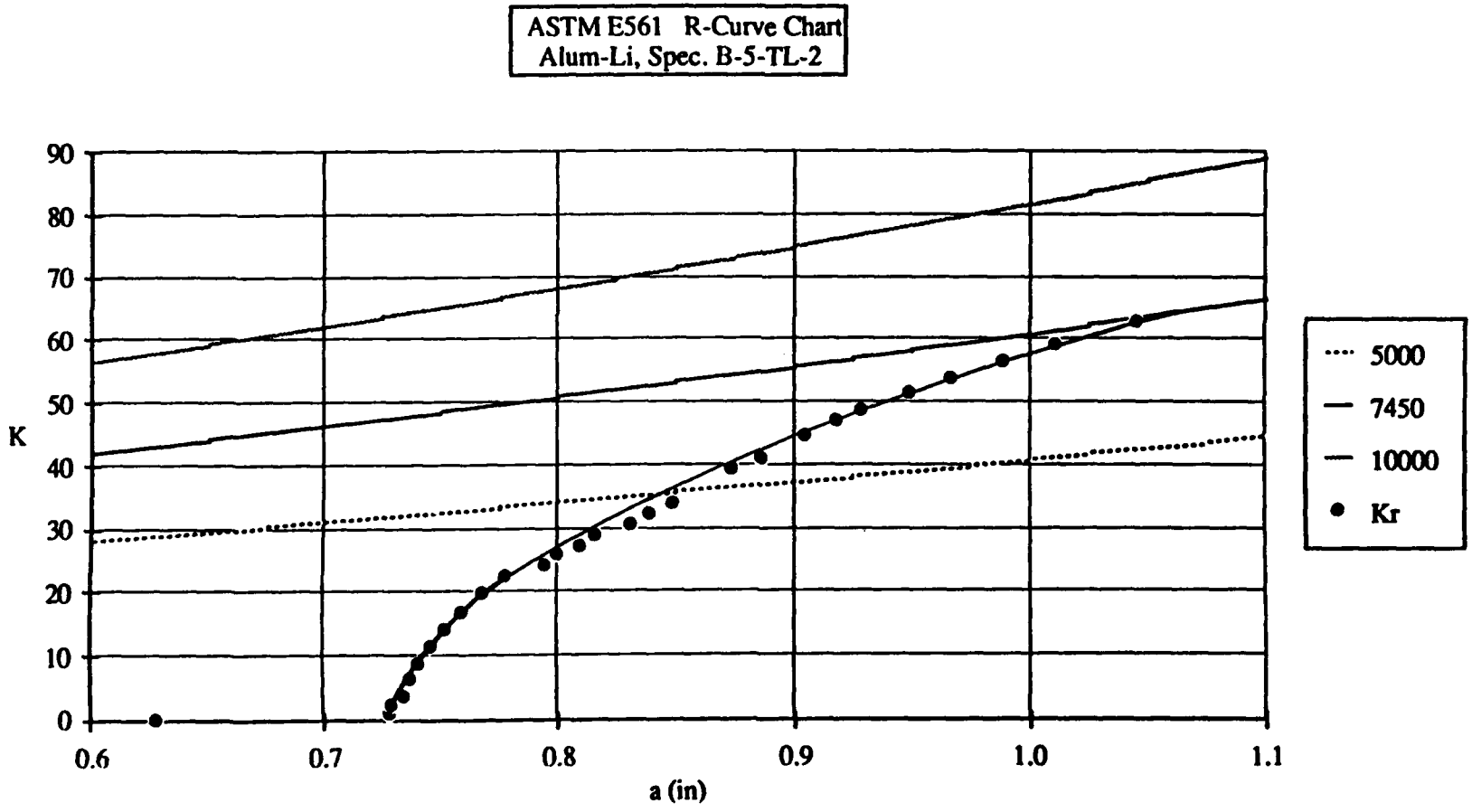


Figure B5 R-Curve Results for 2091-T3 0.063" Sheet (TL). General Dynamics, CA

TABLE B17

General Dynamics, CA

ASTM E561 R Curve CCT Al-Li B-5-TL-3

W = 3.996 in
B = 0.0642 in
a = 1.2500 in
a/2 = 0.6250 in

Fty = 41.10 ksi
Pmax = 7290 lb

	Loads		
a eff	5000	7290	10000
0.6	28	41	57
0.6	29	42	58
0.7	30	43	60
0.7	31	45	61
0.7	31	46	63
0.7	32	47	64
0.8	33	48	66
0.8	34	49	67
0.8	34	50	69
0.8	35	51	70
0.9	36	52	72
0.9	37	54	74
0.9	38	55	75
0.9	38	56	77
1.0	39	57	79
1.0	40	59	80
1.0	41	60	82
1.0	42	61	84
1.1	43	63	86
1.1	44	64	88
1.1	45	66	90

Load	a (half)	a plastic	a eff	K
0	0.6250	0.0000	0.6250	0
200	0.7250	0.0002	0.7252	1
600	0.7250	0.0014	0.7264	4
1000	0.7250	0.0039	0.7289	6
1400	0.7250	0.0076	0.7326	9
1800	0.7250	0.0125	0.7375	12
2000	0.7250	0.0155	0.7405	13
2400	0.7250	0.0223	0.7473	16
2800	0.7250	0.0304	0.7554	18
3200	0.7250	0.0397	0.7647	21
3600	0.7250	0.0502	0.7752	24
3800	0.7250	0.0559	0.7809	26
4200	0.7250	0.0683	0.7933	29
4600	0.7250	0.0820	0.8070	32
4800	0.7250	0.0892	0.8142	33
5200	0.7250	0.1047	0.8297	37
5600	0.7250	0.1215	0.8465	40
5800	0.7250	0.1303	0.8553	42
6000	0.7250	0.1394	0.8644	44
6400	0.7250	0.1586	0.8836	47
6600	0.7250	0.1687	0.8937	49
6800	0.7250	0.1791	0.9041	51
7000	0.7250	0.1898	0.9148	53
7200	0.7250	0.2008	0.9258	55

$K_c = 55.4 \text{ Ksi}\sqrt{\text{in}}$

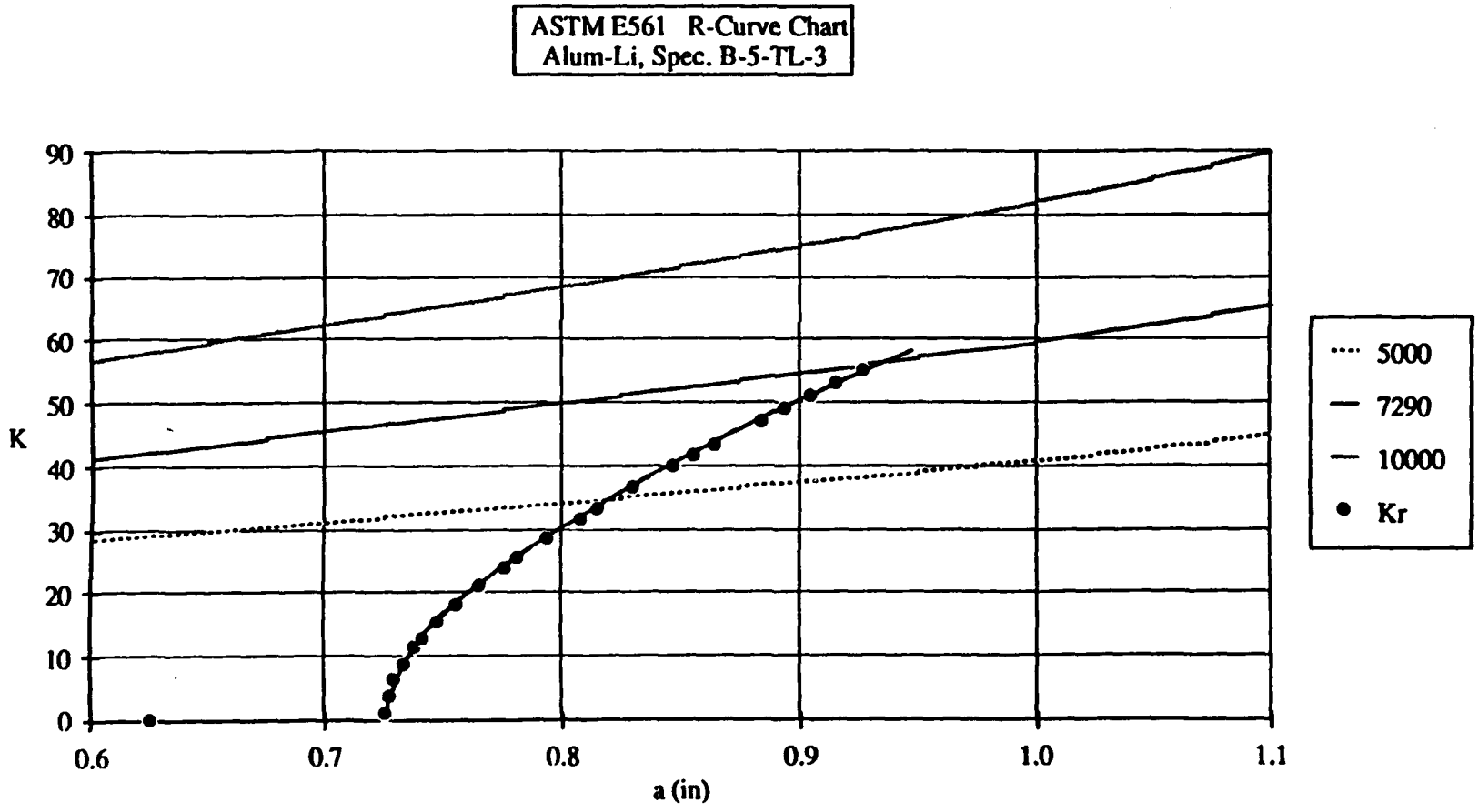


Figure B6 R-Curve Results for 2091-T3 0.063" Sheet (TL). General Dynamics, CA.

TABLE B18

MCAIR

R-CURVE TOUGHNESS DATA FOR PECHINEY 2091
ALUMINUM LITHIUM ALLOY

SPECIMEN IDENTIFICATION	ORIENTATION	SLOT LENGTH 2a, (IN)	PRECRACK LENGTH 2a, (IN)	FINAL CRACK LENGTH 2a, (IN)	LOAD AT FAILURE (LB)	PLANE STRESS FRACTURE TOUGHNESS, Kc, (KSI(IN)^.5)
1	LT-L	1.9915	2.1006	2.2480	10,900	57.0
2		1.9945	2.1000	2.2566	10,980	57.4
AVERAGE		------	------	------	10,940	57.2
3	L-LT	1.9925	2.0993	2.2120	10,940	57.1
4		1.9965	2.1015	2.1815	10,900	55.9
AVERAGE		------	------	------	10,920	56.5

DATA COLLECTED AND REDUCED PER ASTM STANDARD TEST METHOD E561-81.

The four toughness specimens were tested in accordance with ASTM Standard Test Method E561-81. The specimens were precracked to a total crack length, 2a, equal to 35% of the width, as is required per the standard. A stress ratio of 0.1 was used for precracking. The specimens were statically failed using a loading rate of 3000 pound/minute. Cathetometers were used to monitor crack length during static loading to determine the final crack length, at failure, which is required for toughness calculations. Table B18 presents toughness test data. All four specimens had a plane stress toughness value in the range of 56 to 57 ksi(in)^.5. It should be noted that no plastic zone corrections were incorporated into the toughness calculations.

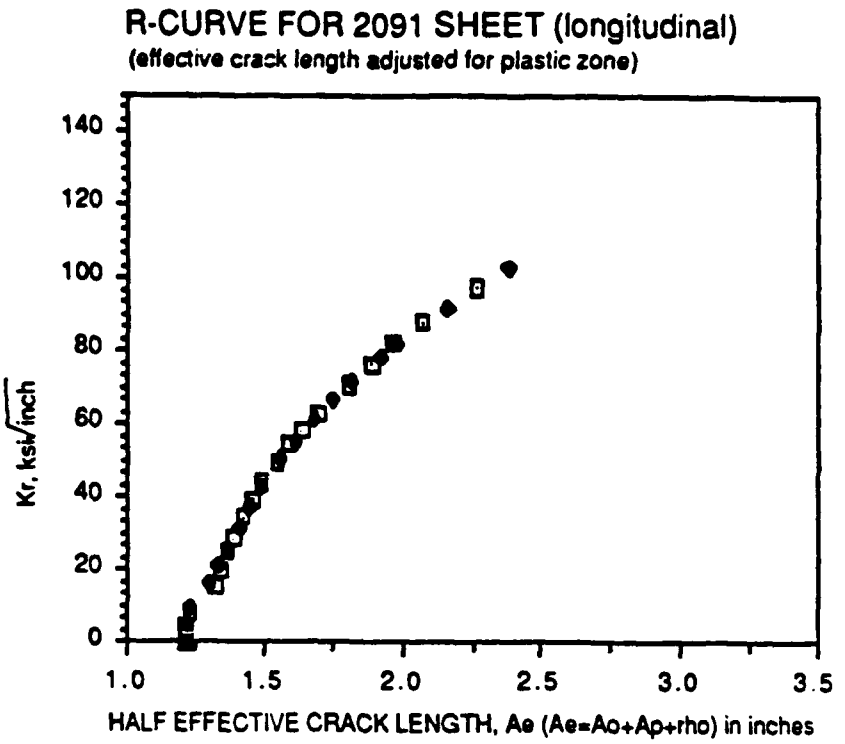


Figure B7 R-Curve Results for 2091-T3 0.063" Sheet (longitudinal) Martin Marietta, LA.

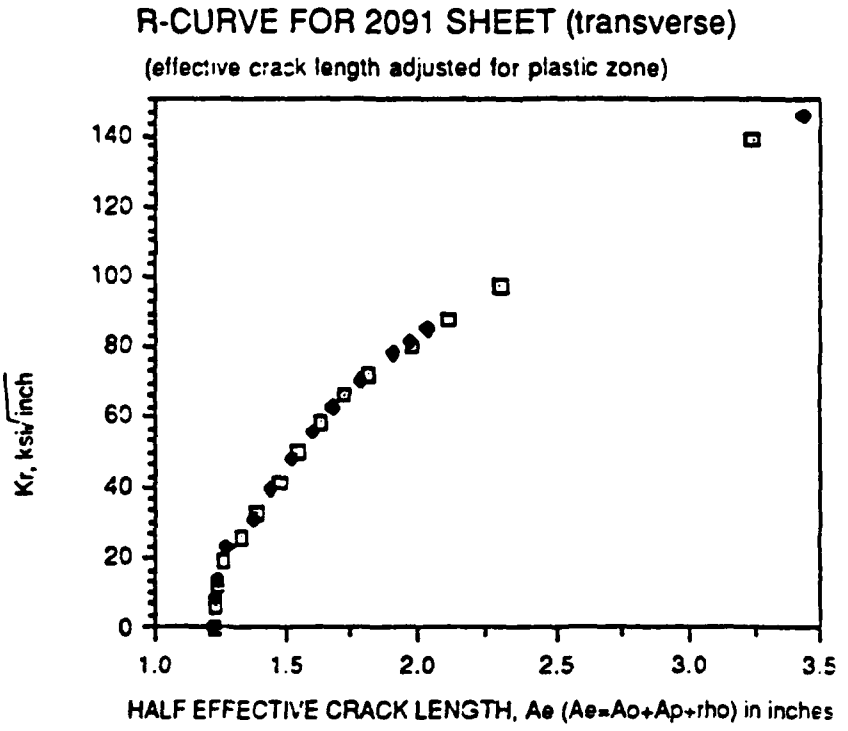


Figure B8 R-Curve Results for 2091-T3 0.063" Sheet (transverse). Martin Marietta

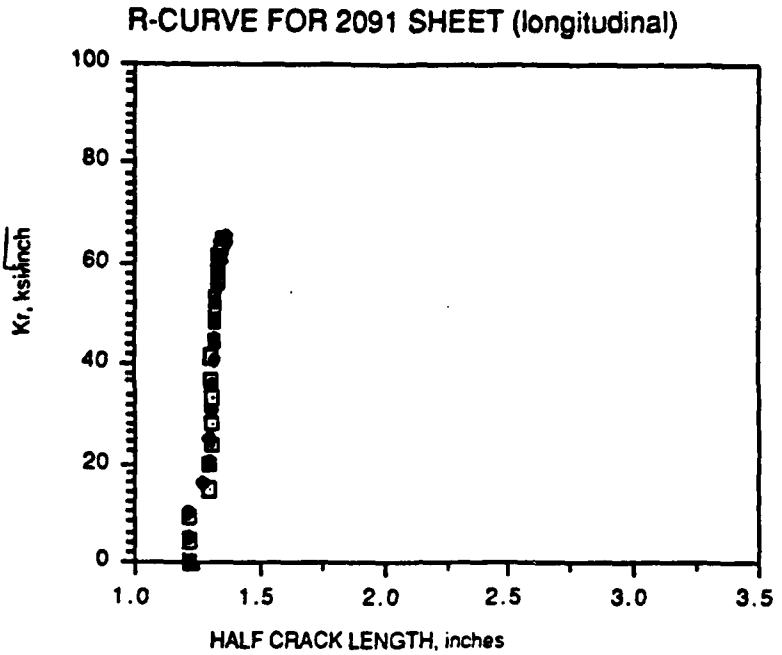


Figure B9 R-Curve Results for 2091-T3 0.063" Sheet (longitudinal). Martin Marietta, LA.

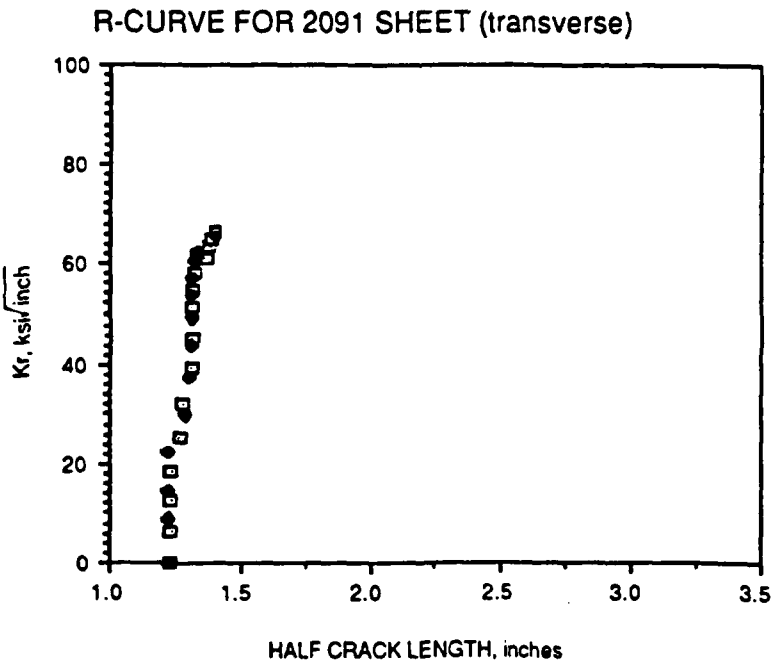


Figure B10 R-Curve Results for 2091-T3 0.063" Sheet (transverse). Martin Marietta, LA.

TABLE B19

Martin Marietta, LA

DATA FOR SPECIMEN NO. 4, 2091

LONGITUDINAL SHEET

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi √inch	
			Not Adjusted	Adjusted for Plasticity
0.0	1.215	1.215	0.0	0.0
1.17	1.215	1.217	4.81	4.55
2.54	1.220	1.229	10.47	9.86
3.71	1.270	1.294	15.69	15.85
4.79	1.295	1.336	20.51	20.87
5.76	1.300	1.361	24.73	25.35
7.08	1.310	1.406	30.54	31.71
8.21	1.310	1.442	35.42	37.24
9.38	1.315	1.493	40.56	43.31
10.41	1.320	1.560	45.13	50.26
11.28	1.320	1.615	48.90	55.05
12.07	1.325	1.680	52.45	61.05
12.70	1.330	1.756	55.30	66.92
13.29	1.330	1.821	57.90	71.84
13.78	1.340	1.919	60.33	78.02
14.12	1.345	1.986	61.97	82.10
14.51	1.365	2.159	64.30	91.36
14.80	1.370	2.381	65.74	103.09

Thickness = .063 inch
Yield = 40.9 ksi
Specimen Width = 8.00 inch

TABLE B20

Martin Marietta, LA

DATA FOR SPECIMEN NO. 5 2091

LONGITUDINAL SHEET

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi $\sqrt{inch}$	
			Not Adjusted	Adjusted for Plasticity
0.0	1.220	1.220	0.0	0.0
1.06	1.220	1.222	4.37	4.12
2.09	1.220	1.226	8.62	8.12
3.48	1.295	1.317	14.90	15.04
4.67	1.300	1.340	20.05	20.36
5.55	1.305	1.362	23.88	24.48
6.53	1.310	1.390	28.17	29.09
7.62	1.310	1.442	32.67	34.33
8.52	1.310	1.453	36.76	38.80
9.54	1.310	1.494	41.16	44.03
10.32	1.315	1.549	44.63	49.59
11.14	1.315	1.599	48.17	54.60
11.74	1.315	1.640	50.77	58.47
12.39	1.320	1.699	53.71	63.08
13.19	1.330	1.809	57.46	70.97
13.71	1.335	1.891	59.77	76.77
14.71	1.335	1.974	61.88	81.95
14.52	1.340	2.076	63.57	87.94
14.79	1.355	2.262	65.22	97.62

Thickness = .063 inch
Yield = 40.9 ksi
Specimen Width = 8.00 inch

TABLE B21

Martin Marietta, LA

DATA FOR SPECIMEN NO. 6 2091

TRANSVERSE SHEET

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi $\sqrt{\text{inch}}$	
			Not Adjusted	Adjusted for Plasticity
0.0	1.215	1.215	0.0	0.0
2.19	1.215	1.222	9.01	8.49
3.50	1.220	1.238	14.43	13.60
5.47	1.220	1.271	22.56	23.05
7.00	1.282	1.373	29.79	30.90
8.75	1.295	1.445	37.47	39.65
10.16	1.300	1.521	43.61	48.23
11.43	1.300	1.605	49.19	56.11
12.43	1.305	1.680	53.49	62.77
13.31	1.305	1.781	57.28	70.74
13.95	1.320	1.906	60.48	78.51
14.21	1.327	1.965	61.83	81.87
14.42	1.330	2.028	62.82	85.66
14.62	1.395	3.433	65.73	146.00

Thickness = .063 inch
Yield = 40.9 ksi
Specimen width = 8.00 inch

TABLE B22

Martin Marietta, LA

DATA FOR SPECIMEN NO. 7, 2091

TRANSVERSE SHEET

Load, kips	Half Crack Length (c) inch	Half Crack Length, (c + rho) inch	Corresponding Fracture Toughness, ksi $\sqrt{\text{inch}}$	
			Not Adjusted	Adjusted for Plasticity
0.0	1.225	1.225	0.0	0.0
1.52	1.225	1.228	6.28	5.92
3.00	1.225	1.238	12.40	11.66
4.51	1.225	1.259	18.65	18.92
7.00	1.260	1.324	25.20	25.94
7.50	1.275	1.380	31.81	33.16
9.11	1.305	1.470	39.20	41.69
10.51	1.305	1.547	45.23	50.43
11.86	1.305	1.635	51.04	58.91
12.74	1.310	1.729	54.96	66.33
13.40	1.320	1.817	58.09	72.27
13.89	1.360	1.977	61.40	80.55
14.28	1.375	2.107	63.58	87.73
14.56	1.390	2.299	65.30	97.73
14.77	1.400	3.245	66.56	139.00

Thickness = .063 inch
Yield = 40.9 ksi
Specimen Width = 8.00 inch

TABLE B23

FATIGUE RESULTS WITH R=0.1 AND Kt=1.0 FOR

PECHINEY 2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
GENERAL DYNAMICS, CALIF.	LONG	21.8	10,000,000 *
		25.0	1,888,000
		27.0	10,140,000 *
		30.0	303,000
		32.0	363,000
		35.0	143,000
		38.0	122,000

(*):INDICATES A RUN-OUT TEST

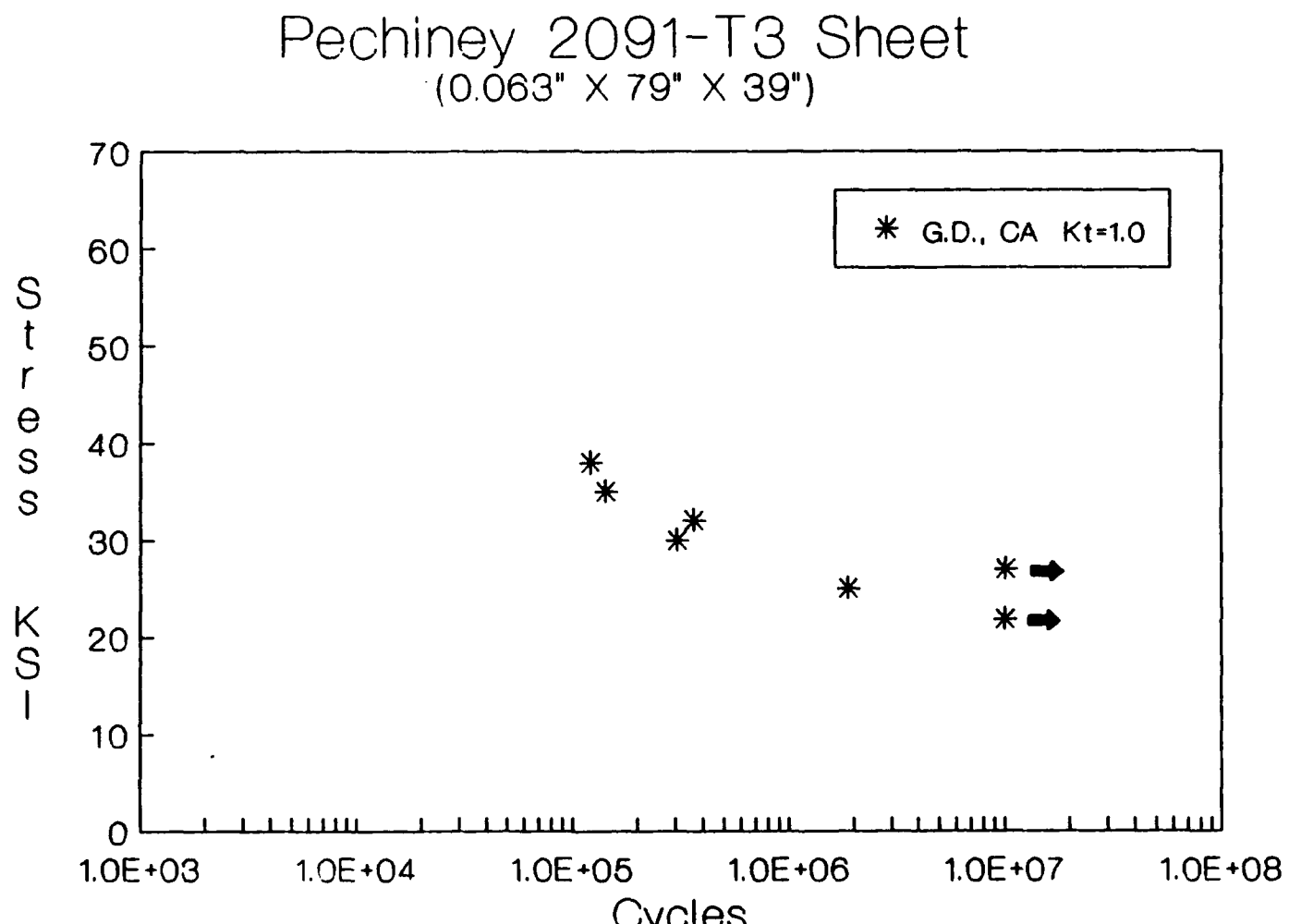


Figure B11 Fatigue Results for 2091-T3 0.063" Sheet (R=0.1, K_t=1.0, and longitudinal). General Dynamics, CA

TABLE B24

FATIGUE RESULTS WITH R=0.1 AND Kt=3.0 FOR

PECHINEY 2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
GENERAL DYNAMICS, CALIF.	LONG	10.0	10,000,000 *
		12.0	319,000
		13.0	10,330,000 *
		13.5	193,000
		14.5	158,000
		16.0	163,000
		20.0	47,000
		25.0	15,000

(*): INDICATES A RUN-OUT TEST

TABLE B25

FATIGUE RESULTS WITH R=0.1 AND Kt=2.8 FOR

PECHINEY 2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES	
LTV	LONG	15.4	1,000,000	*
		15.4	410,760	
		15.5	700,100	
		16.5	192,020	
		16.5	236,950	
		18.5	202,250	
		18.7	203,450	*
		19.0	155,800	
		22.1	83,190	
		22.4	76,450	
		22.4	49,000	

(*): INDICATES A RUN-OUT TEST
(*): INDICATES SPECIMEN FAILED IN GRIP

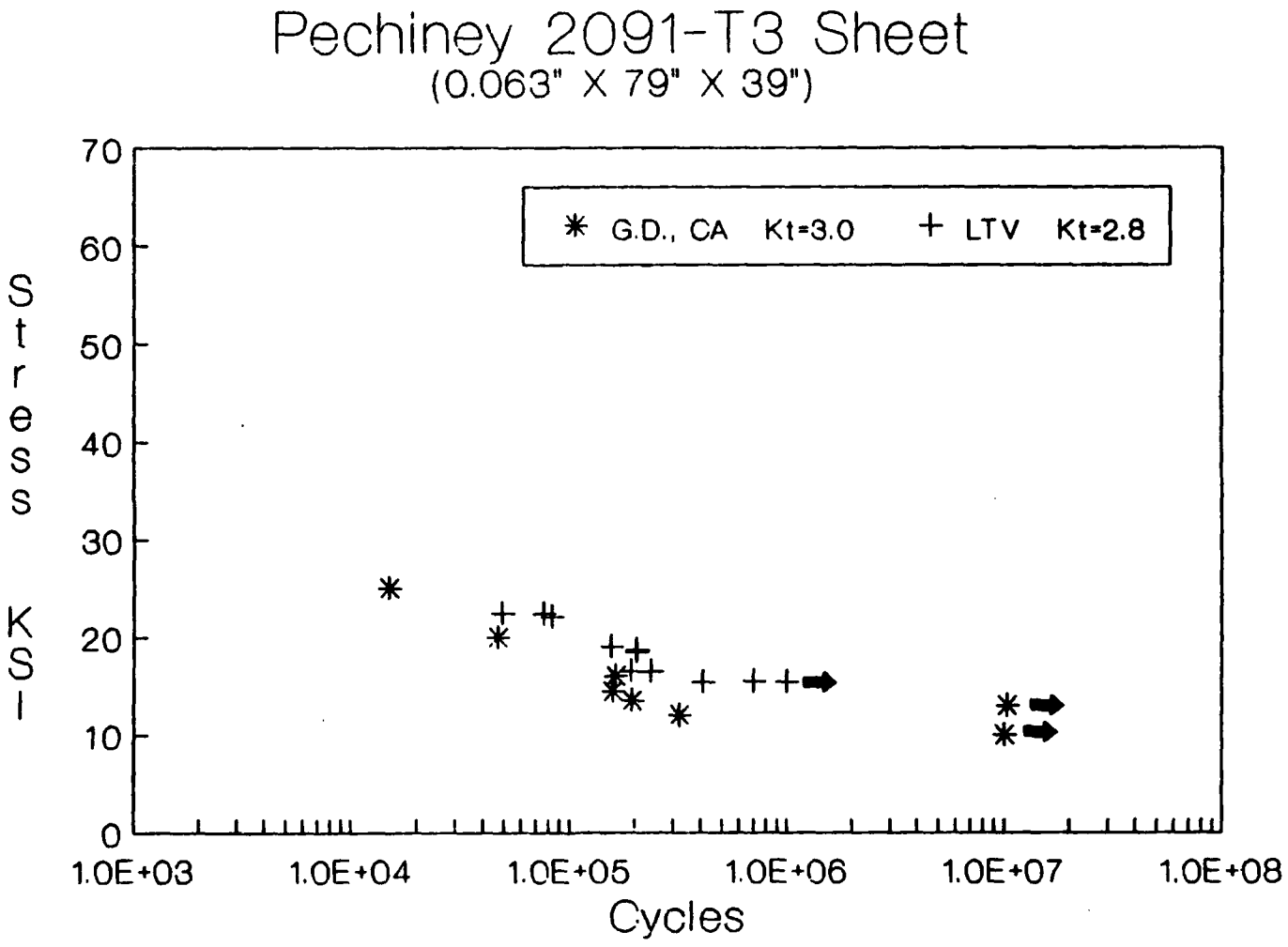


Figure B12 Fatigue Results for 2091-T3 0.063" Sheet (R=0.1, $K_t \geq 2.8$, and Longitudinal). General Dynamics, CA and LTV.

TABLE B26

FATIGUE RESULTS WITH R=0.1 AND Kt=2.8 FOR

PECHINEY 2091-T3 SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
LTV	L TRANS	15.5	1,500,000 *
		16.0	369,700
		18.7	94,490
		18.7	138,430
		22.1	84,900
		22.5	52,100

(*): INDICATES A RUN-OUT TEST

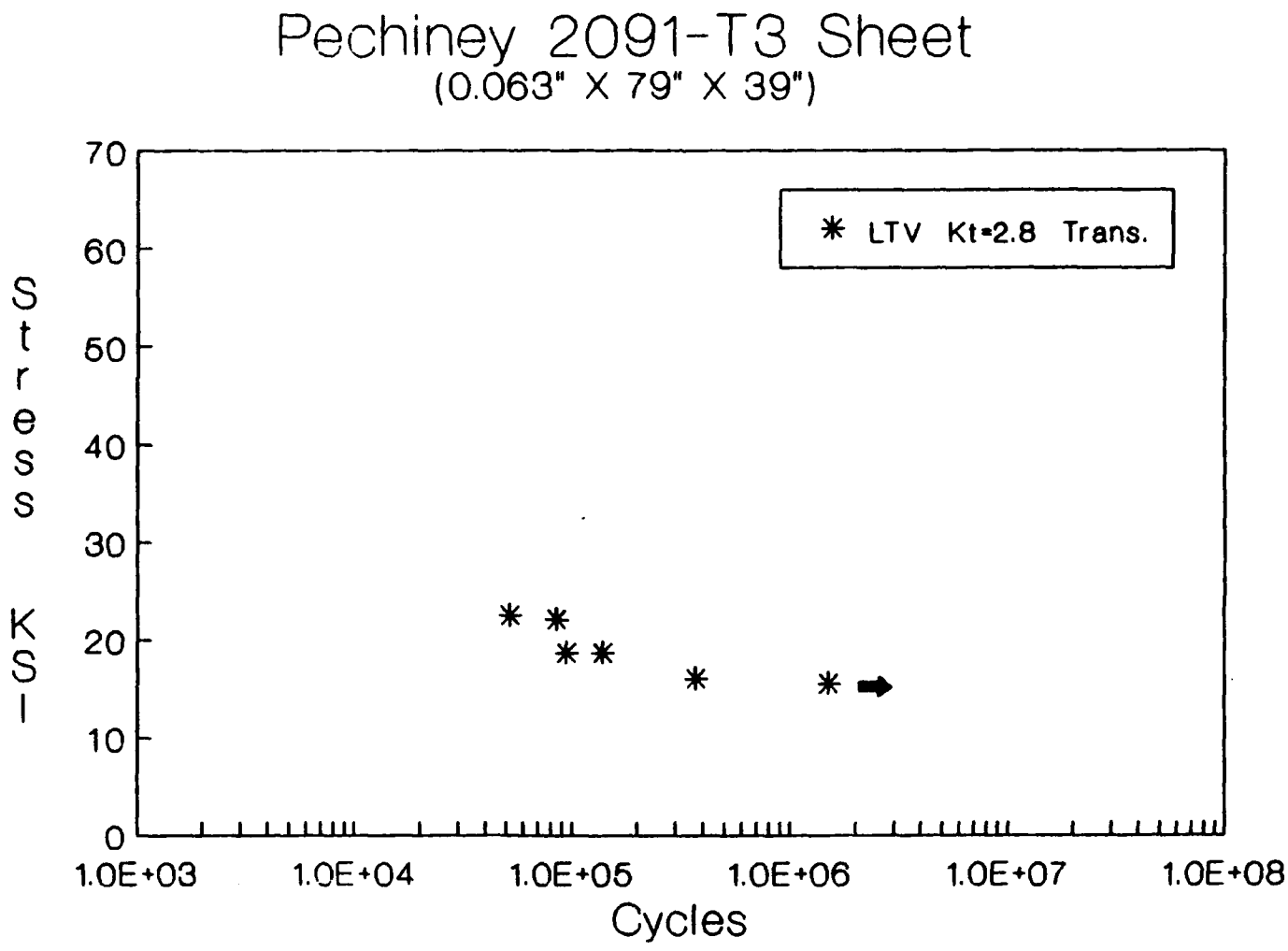


Figure B13 Fatigue Results for 2091-T3 0.063" Sheet (R=0.1, K_t=2.8, and Transverse). LTV.

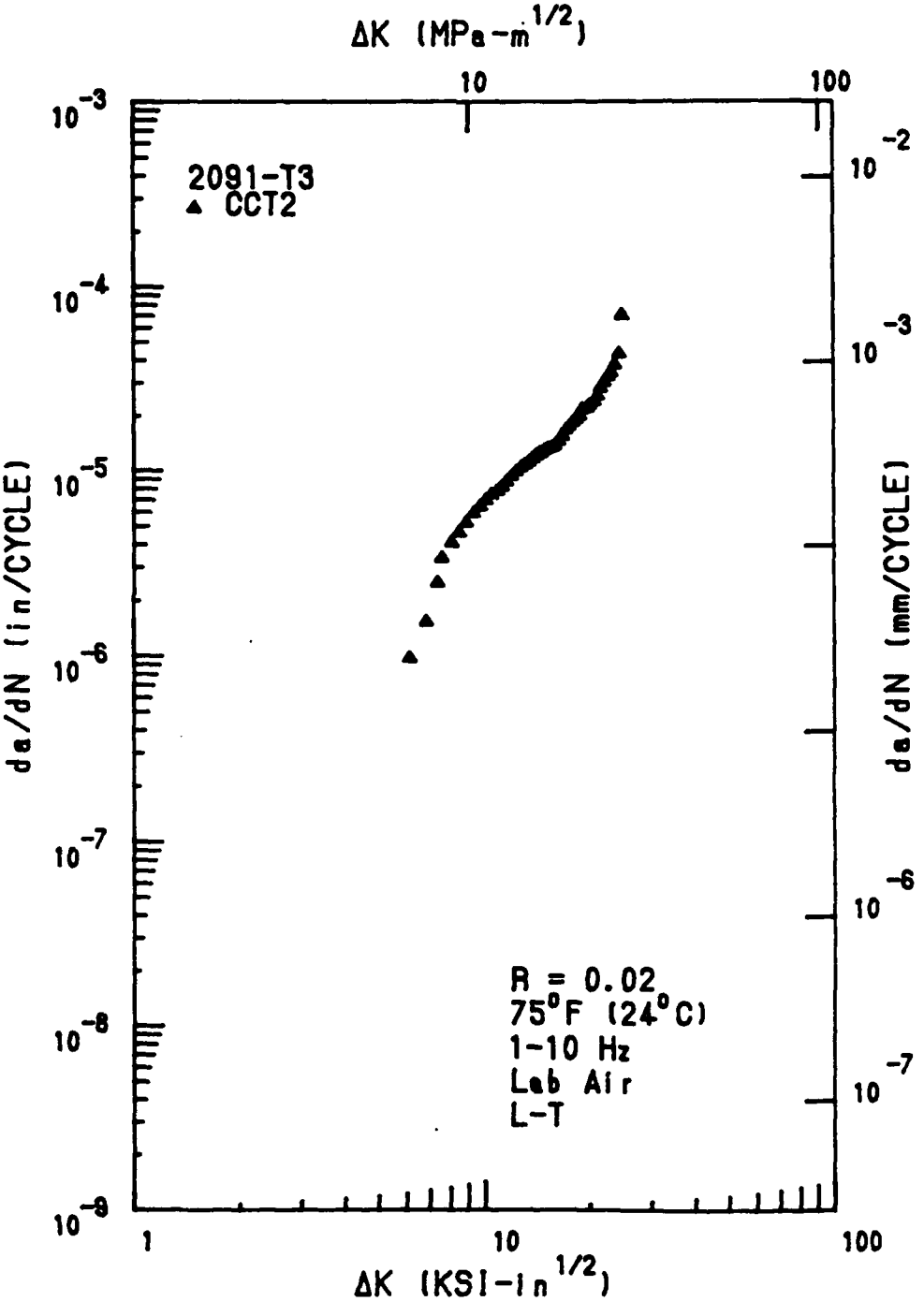


Figure B14 Fatique Crack Growth Rate Data for Pechinev 2091-T3 0.063" Sheet (L-T Orientation). McDonnel Aircraft LA.

TABLE B27A

Fatigue Crack Growth Rate Data Associate with Figure B14

Seven Point Incremental Polynomial Method per ASTM E647

05-24-1989

Specimen Number: CCT2 Specimen Type: CCT

B= 0.0636 in W= 3.9120 in An= 0.0000

Pmax= X2400.000 lbs Pmin= 48.000 lbs

R= 0.02 Frequency= 0.00 hz. 1-10 Hz

Test Temperature= 75 F Environment= LAB AIR

PT	CYCLES	2*Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.1410				
2	70.00	0.1610				
3	180.00	0.2000				
4	280.00	0.2500	0.2647	0.973260	6.11	.9778E-06
5	335.00	0.3030	0.3281	0.966404	6.82	.1539E-05
6	365.00	0.3620	0.3800	0.981514	7.35	.2490E-05
7	376.00	0.4000	0.4016	0.998027	7.56	.3379E-05
8	391.00	0.4520	0.4537	0.999719	8.05	.4090E-05
9	401.50	0.5000	0.4998	0.999702	8.46	.4636E-05
10	411.50	0.5500	0.5477	0.999601	8.88	.5241E-05
11	421.50	0.6000	0.6028	0.999563	9.34	.5911E-05
12	429.50	0.6500	0.6515	0.999662	9.73	.6398E-05
13	436.50	0.7000	0.6978	0.999668	10.10	.6891E-05
14	443.50	0.7500	0.7490	0.999877	10.49	.7391E-05
15	450.50	0.8000	0.8022	0.999878	10.90	.7778E-05
16	456.50	0.8500	0.8490	0.999891	11.25	.8186E-05
17	462.50	0.9000	0.8991	0.999886	11.61	.8692E-05
18	468.50	0.9510	0.9526	0.999807	12.01	.9328E-05
19	473.50	1.0000	0.9997	0.999949	12.35	.9865E-05
20	478.50	1.0500	1.0508	0.999833	12.72	.1036E-04
21	483.00	1.1000	1.0995	0.999910	13.07	.1076E-04
22	487.50	1.1500	1.1485	0.999802	13.42	.1119E-04
23	492.00	1.1990	1.1994	0.999766	13.78	.1164E-04
24	496.50	1.2500	1.2520	0.999883	14.16	.1211E-04
25	500.30	1.3000	1.2991	0.999780	14.50	.1246E-04
26	504.30	1.3510	1.3503	0.999818	14.88	.1298E-04
27	508.00	1.4000	1.4000	0.999798	15.24	.1320E-04
28	512.00	1.4510	1.4527	0.999787	15.63	.1339E-04
29	515.30	1.5000	1.4967	0.999660	15.96	.1373E-04
30	519.30	1.5500	1.5513	0.999307	16.37	.1451E-04
31	522.80	1.6010	1.6022	0.999423	16.77	.1549E-04
32	526.00	1.6510	1.6519	0.999943	17.15	.1668E-04
33	528.80	1.7020	1.7016	0.999401	17.55	.1738E-04
34	531.50	1.7500	1.7500	0.999374	17.94	.1835E-04
35	534.00	1.8000	1.7973	0.999416	18.33	.1893E-04
36	537.00	1.8500	1.8540	0.999166	18.81	.1990E-04
37	539.20	1.9010	1.8963	0.998392	19.18	.2162E-04
38	541.80	1.9500	1.9555	0.994549	19.70	.2201E-04
39	543.80	2.0000	2.0027	0.995170	20.13	.2283E-04
+ 40	546.40	2.0770	2.0619	0.994340	20.69	.2384E-04
41	548.40	2.1000	2.1106	0.993083	21.16	.2557E-04
42	550.20	2.1510	2.1547	0.992934	21.60	.2818E-04
43	551.90	2.2020	2.2006	0.996178	22.07	.3026E-04
44	553.40	2.2510	2.2533	0.999111	22.63	.3256E-04
+ 45	554.60	2.2990	2.2930	0.998763	23.06	.3408E-04
46	556.30	2.3510	2.3507	0.996025	23.72	.3749E-04
47	557.90	2.4040	2.4103	0.996563	24.43	.4332E-04
48	559.00	2.4540	2.4471	0.988879	24.88	.6968E-04
49	559.80	2.5030				
50	560.70	2.5510				
++ 51	563.70	2.9950				

* - DATA VIOLATES SIZE REQUIREMENTS

+ Denotes that Data Point + is Invalid per ASTM STANDARD TEST METHOD E 647-83, PARAGRAPH 8.6.4

++ DENOTES THAT DATA POINT IS INVALID PER ASTM STANDARD TEST METHOD E 647-83, PARAGRAPH 7.2.2.

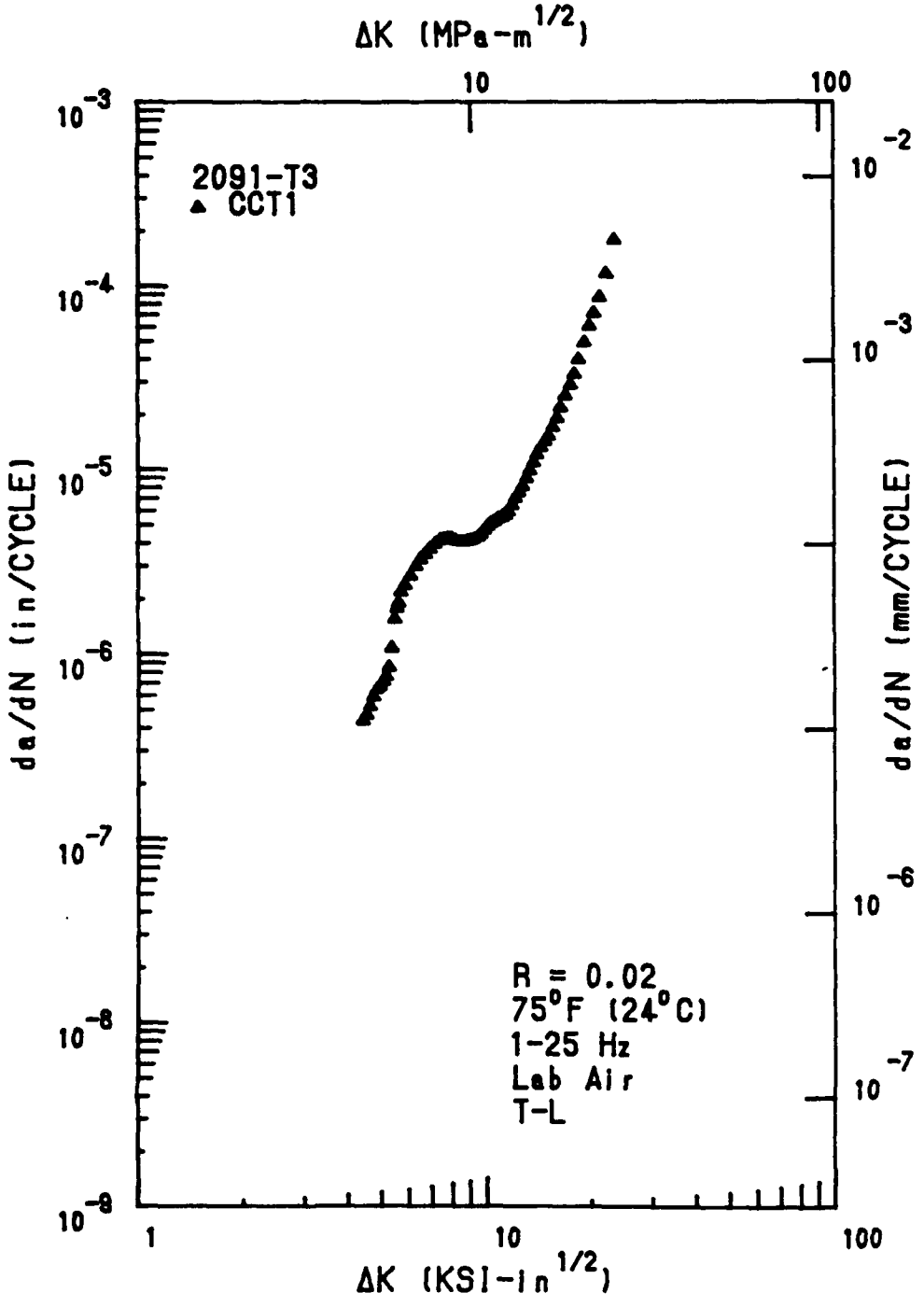


Figure B15 Fatigue Crack Growth Rate Data for Pechiney 2091-T3 0.063" Sheet (T-L Orientation). McDonnell Aircraft LA.

TABLE B27B

Fatigue Crack Growth Rate Data Associated with Figure B15

Seven Point Incremental Polynomial Method per ASTM E647

05-24-1989

Specimen Number: CCT1 Specimen Type: CCT

B= 0.0710 in W= 3.9140 in An= 0.0000

Pmax= %1550.000 lbs Pmin= 31.000 lbs

R= 0.02 Frequency= 0.00 hz. 1-25 Hz

Test Temperature= 75 F Environment= LAB AIR

PT	CYCLES	2*Amess	Areg	MCC	Delta K	da/dN
1	0.00	0.3500				
2	56.00	0.3700				
3	106.00	0.3900				
4	150.00	0.4100	0.4090	0.999848	4.41	.4351E-06
5	198.00	0.4300	0.4305	0.999727	4.53	.4670E-06
6	239.00	0.4500	0.4495	0.997940	4.63	.5195E-06
7	280.00	0.4700	0.4709	0.998823	4.74	.5855E-06
8	315.00	0.4900	0.4922	0.998786	4.85	.6416E-06
9	340.00	0.5110	0.5091	0.998070	4.94	.6670E-06
10	368.00	0.5300	0.5292	0.998938	5.04	.7099E-06
11	398.00	0.5510	0.5508	0.998246	5.15	.7540E-06
12	426.00	0.5700	0.5709	0.996725	5.25	.8441E-06
13	451.00	0.5910	0.5922	0.990044	5.35	.1075E-05
14	474.00	0.6130	0.6186	0.989092	5.47	.1546E-05
15	484.00	0.6300	0.6334	0.994159	5.54	.1771E-05
16	492.00	0.6500	0.6484	0.995252	5.61	.1888E-05
17	500.00	0.6700	0.6660	0.998870	5.69	.2179E-05
18	516.00	0.7000	0.7012	0.998969	5.85	.2358E-05
19	536.00	0.7500	0.7501	0.999727	6.07	.2643E-05
20	554.00	0.8000	0.8000	0.999915	6.29	.2989E-05
21	569.50	0.8500	0.8497	0.999856	6.50	.3258E-05
22	584.50	0.9000	0.9010	0.999814	6.72	.3473E-05
23	597.50	0.9500	0.9476	0.999764	6.92	.3695E-05
24	611.50	1.0000	1.0002	0.999680	7.14	.3946E-05
25	624.50	1.0500	1.0531	0.999512	7.36	.4115E-05
26	635.50	1.1000	1.1000	0.998925	7.56	.4155E-05
27	646.50	1.1510	1.1482	0.999459	7.76	.4214E-05
28	658.50	1.2000	1.1994	0.999734	7.97	.4203E-05
29	671.50	1.2510	1.2522	0.999726	8.19	.4122E-05
30	683.50	1.3000	1.3008	0.999903	8.39	.4058E-05
31	695.50	1.3500	1.3496	0.999904	8.60	.4064E-05
32	707.50	1.4000	1.3985	0.999917	8.81	.4085E-05
33	720.50	1.4500	1.4512	0.999870	9.03	.4113E-05
34	732.50	1.5000	1.4999	0.999909	9.24	.4181E-05
35	744.50	1.5500	1.5501	0.999984	9.46	.4284E-05
36	756.00	1.6000	1.6001	0.999958	9.68	.4448E-05
37	767.00	1.6500	1.6491	0.999852	9.90	.4662E-05
38	778.00	1.7000	1.7012	0.999887	10.14	.4893E-05
39	788.00	1.7500	1.7514	0.999806	10.38	.5070E-05
40	797.00	1.8000	1.7985	0.999717	10.60	.5189E-05
41	806.50	1.8500	1.8488	0.999671	10.85	.5389E-05
42	816.00	1.9000	1.9005	0.999668	11.11	.5494E-05
43	825.50	1.9500	1.9523	0.999742	11.37	.5662E-05
44	833.50	2.0010	1.9977	0.999712	11.61	.5906E-05
45	842.50	2.0500	2.0513	0.999295	11.90	.6375E-05
46	850.50	2.1020	2.1029	0.999277	12.19	.6942E-05
47	857.50	2.1500	2.1518	0.999816	12.47	.7457E-05
48	863.50	2.2000	2.1986	0.999820	12.74	.8065E-05
49	869.50	2.2500	2.2479	0.999182	13.05	.8892E-05
50	875.50	2.3000	2.3028	0.999180	13.39	.9842E-05
51	880.50	2.3500	2.3524	0.999659	13.72	.1085E-04
52	884.50	2.4000	2.3965	0.999637	14.02	.1201E-04
53	889.00	2.4520	2.4539	0.999541	14.43	.1315E-04
54	892.60	2.5010	2.5030	0.999535	14.80	.1412E-04
55	895.60	2.5500	2.5454	0.999418	15.13	.1518E-04
56	899.20	2.6000	2.6021	0.999056	15.59	.1691E-04
57	902.20	2.6510	2.6532	0.999063	16.03	.1893E-04
58	904.70	2.7010	2.7003	0.999434	16.45	.2174E-04
+ 59	907.00	2.7510	2.7522	0.999329	16.95	.2524E-04
+ 60	909.00	2.8010	2.8043	0.999671	17.48	.2883E-04
61	910.50	2.8500	2.8482	0.999296	17.95	.3297E-04
62	912.00	2.9000	2.8992	0.997024	18.53	.3954E-04
63	913.40	2.9500	2.9563	0.996342	19.24	.4917E-04
64	914.40	3.0010	3.0057	0.998617	19.89	.6012E-04
65	915.10	3.0500	3.0479	0.999773	20.49	.7067E-04
66	915.80	3.1000	3.1003	0.997087	21.30	.8669E-04
67	916.40	3.1500	3.1552	0.983215	22.22	.1161E-03
68	916.90	3.2010	3.2199	0.966572	23.44	.1787E-03
69	917.20	3.2510				
++ 70	917.30	3.3000				
++ 71	917.40	3.3510				

+ DENOTES THAT DATA POINT IS INVALID PER ASTM STANDARD TEST METHOD E647-83 PARA 9.6.4

++ " " " " " " " " " " " " PARA 7.2.2.

* - DATA VIOLATES SIZE REQUIREMENTS

2091-T8X SHEET
(0.063"x79"x79")

TABLE B28

TENSILE RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	MODULUS (MSI)
NORTHROP	RT	LONG	62.9	47.5	15.6		11.1
			63.0	47.4	16.5		11.1
			63.1	47.7	18.3		10.5
GRUMMAN	RT	LONG	61.8	47.3	15.5		10.9
			61.8	47.7	16.5		11.2
			62.8	47.3	15.5		11.6
GENERAL DYNAMICS, TEXAS	RT	LONG	65.6	49.7	14.1		
			64.7	49.1	14.1		
		AVERAGE	63.2	48.0	15.8		11.1
		STANDARD DEVIATION	1.3	0.9	1.4		0.4

TABLE B29

TENSILE RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	MODULUS (MSI)
NORTHROP	RT	L TRANS	65.9	47.5	14.3		11.0
			66.0	47.6	13.6		11.4
			66.6	48.0	14.0		11.2
GRUMMAN	RT	L TRANS	64.4	46.3	12.0		11.0
			64.6	46.6	15.0		11.4
			64.8	46.7	14.0		11.5
GENERAL DYNAMICS, TEXAS	RT	L TRANS	67.2	50.2	11.0		
			67.5	50.7	10.4		
		AVERAGE	65.9	48.0	13.0		11.3
	STANDARD DEVIATION		1.2	1.7	1.7		0.2

TABLE B30

COMPRESSION RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
NORTHROP	RT	LONG	46.8	11.6
			46.7	11.5
			46.9	11.5
GRUMMAN	RT	LONG	45.3	11.6
			47.9	11.5
			46.3	11.5
GENERAL DYNAMICS, TEXAS	RT	LONG	48.8	
			49.7	
		AVERAGE	47.3	11.5
		STANDARD DEVIATION	1.4	0.1

TABLE B31

COMPRESSION RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
NORTHROP	RT	L TRANS	53.0	11.5
			52.7	11.5
			53.0	11.3
GRUMMAN	RT	L TRANS	51.3	11.2
			51.3	11.4
			52.3	11.7
GENERAL DYNAMICS, TEXAS	RT	L TRANS	53.1	
			53.7	
		AVERAGE	52.5	11.4
		STANDARD DEVIATION	0.9	0.2

TABLE B32

COMPRESSION RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
GRUMMAN	RT	45	44.6	11.4
			45.5	11.3
			45.2	11.4
		AVERAGE	45.1	11.4
		STANDARD DEVIATION	0.5	0.1

TABLE B33

SLOTTED SHEAR RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 7" X 3")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	LONG	39.4
		35.5
		39.6
GRUMMAN	LONG	38.2
		40.0
		39.1
GENERAL DYNAMICS, TEXAS	LONG	40.9
		42.0
	AVERAGE	39.3
	STANDARD DEVIATION	1.9

TABLE B34

SLOTTED SHEAR RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	L TRANS	41.8
		41.9
		41.9
GRUMMAN	L TRANS	41.1
		41.7
		40.7
GENERAL DYNAMICS, TEXAS	L TRANS	38.4
	AVERAGE	41.1
	STANDARD DEVIATION	1.3

TABLE B35

BEARING RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	LONG	1.5	94.9	67.6
			94.9	68.3
			94.9	67.2
GRUMMAN	LONG	1.5	91.7	65.5
			91.7	65.4
			91.7	66.2
GENERAL DYNAMICS, TEXAS	LONG	1.5	88.6	75.6
			93.8	78.2
		AVERAGE	92.8	69.3
		STANDARD DEVIATION	2.3	4.9

TABLE B36

BEARING RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	L TRANS	1.5	96.3	67.6
			96.3	67.1
			96.2	68.0
GRUMMAN	L TRANS	1.5	91.9	65.0
			92.4	66.7
			93.1	66.5
GENERAL DYNAMICS, TEXAS	L TRANS	1.5	92.9	78.8
			92.3	78.5
		AVERAGE	93.9	69.8
		STANDARD DEVIATION	2.0	5.5

TABLE B37

BEARING RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	LONG	2.0	117.2	80.0
			118.6	79.8
			117.1	81.5
GRUMMAN	LONG	2.0	116.4	79.2
			116.4	78.7
			116.4	78.6
GENERAL DYNAMICS, TEXAS	LONG	2.0	106.0	88.1
			117.0	92.2
		AVERAGE	115.6	82.3
		STANDARD DEVIATION	4.0	5.1

TABLE B38

BEARING RESULTS FOR PECHINEY

2091-T8X SHEET (0.063" X 79" X 39")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
NORTHROP	L TRANS	2.0	120.4	81.6
			120.1	84.0
			118.6	82.0
GRUMMAN	L TRANS	2.0	121.8	83.2
			120.0	81.8
			117.6	80.8
GENERAL DYNAMICS, TEXAS	L TRANS	2.0	114.0	95.8
			105.0	93.6
		AVERAGE	117.2	85.4
		STANDARD DEVIATION	5.5	5.9

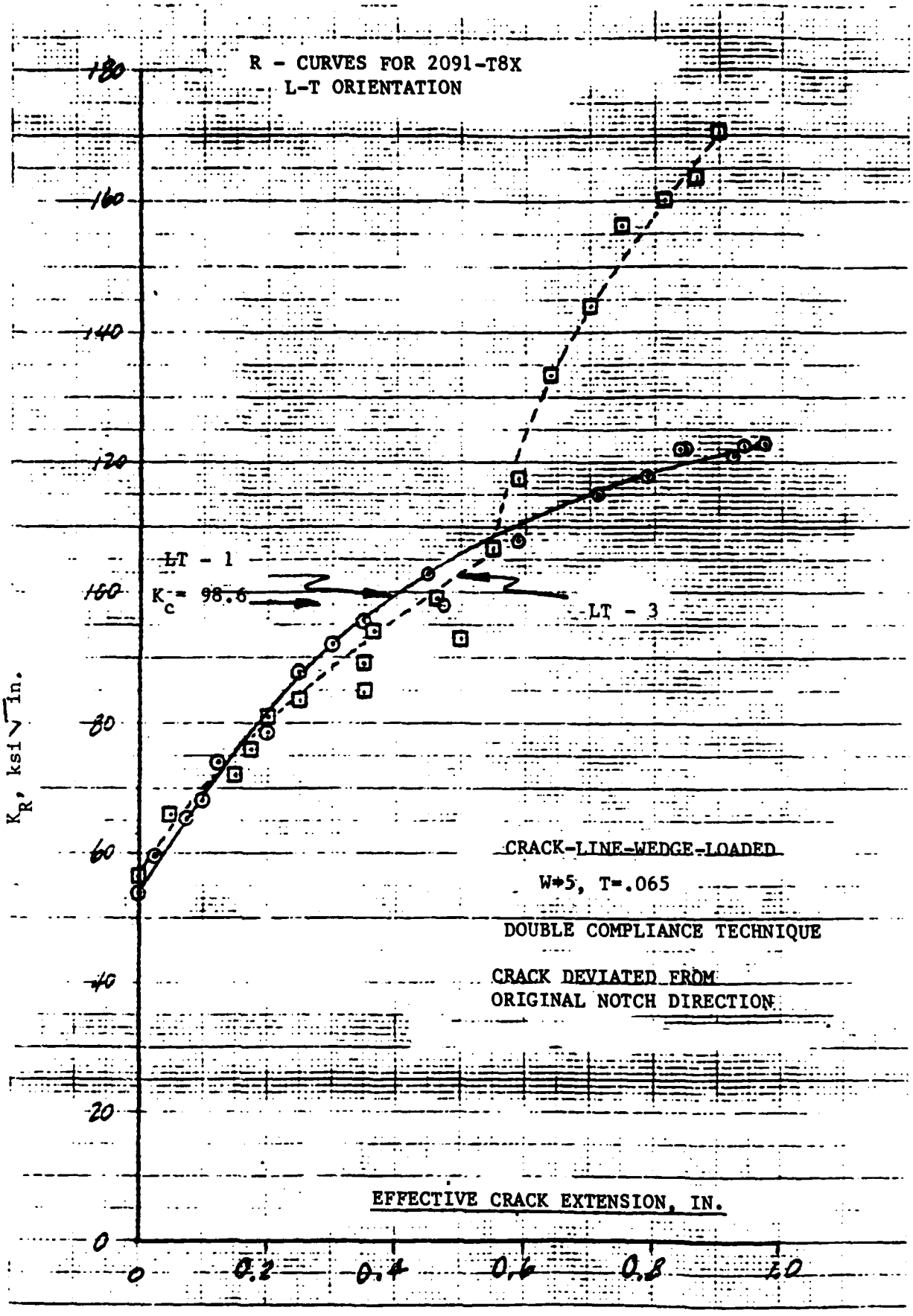


Figure B16 R-Curve Results for 2091-T8X 0.063" Sheet (L-T). Grumman.

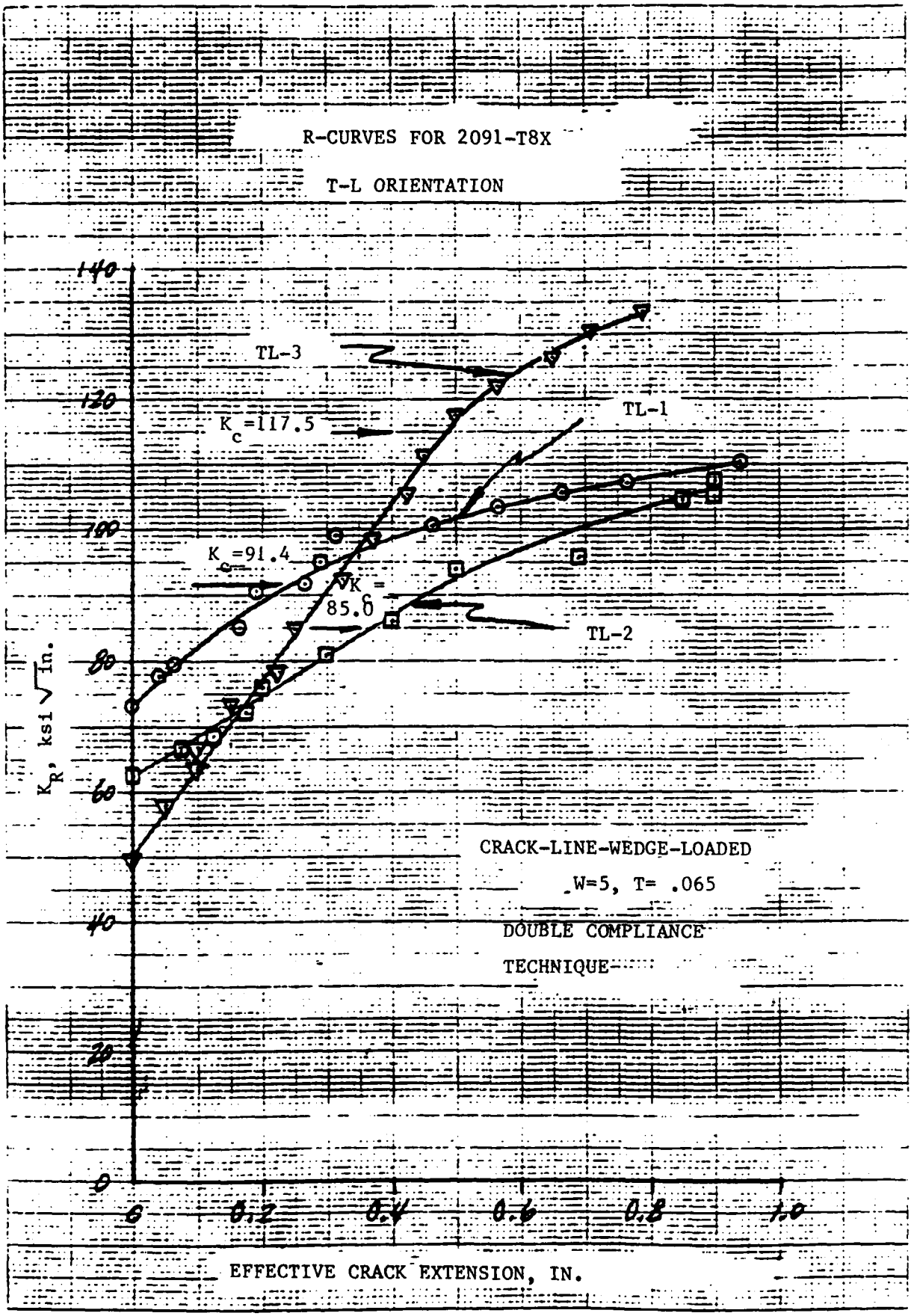


Figure B17 R-Curve Results for 2091-T8X 0.063" Sheet (T-L). Grumman.

TABLE B39

General Dynamics, Texas

Pechiney 2091-T81 Sheet
(0.063" X 79" X 39")
Average Results of R-Curve Tests

	K_{R25}, ksi-$in^{\frac{1}{2}}$
L-T	91.2
T-L	81.4

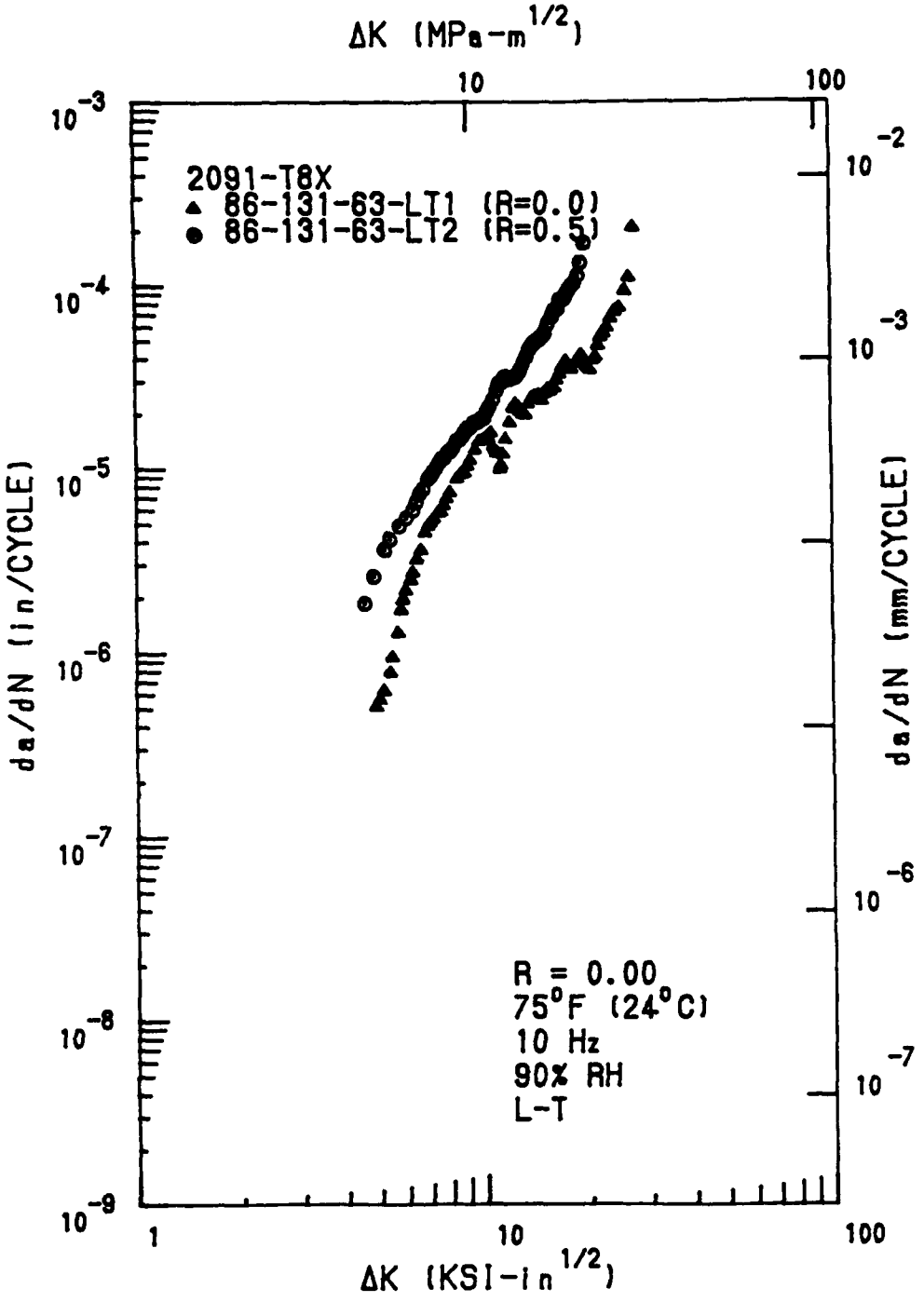


Figure 818 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.063" Sheet (L-T Orientation). Grumman.

TABLE B40

Fatigue Crack Growth Rate Data Associated with Figure B18

Seven Point Incremental Polynomial Method per ASTM E647

04-18-1989

Specimen Number: B6-131-63-LT-1 Specimen Type: CCT

B= 0.0640 in W= 3.7460 in An= 0.0000

Pmax= 1.440 kips Pmin= 0.000 kips

R= 0.00 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	Ameas*2	Areg	MCC	Delta K	da/dN
1	0.00	0.3250				
2	75.00	0.3550				
3	150.00	0.3800				
4	195.00	0.4150	0.4103	0.995078	4.86	.5084E-06
5	240.00	0.4350	0.4340	0.993165	5.00	.5563E-06
6	280.00	0.4580	0.4575	0.989971	5.14	.6249E-06
7	340.00	0.4880	0.4941	0.995748	5.35	.7864E-06
8	360.00	0.5100	0.5089	0.993468	5.43	.9568E-06
9	390.00	0.5380	0.5397	0.993278	5.60	.1295E-05
10	410.00	0.5600	0.5662	0.993839	5.75	.1716E-05
11	420.00	0.5830	0.5826	0.998280	5.83	.1955E-05
12	430.00	0.6050	0.6029	0.998490	5.94	.2191E-05
13	445.00	0.6400	0.6408	0.999616	6.14	.2493E-05
14	453.00	0.6600	0.6594	0.997553	6.23	.2734E-05
15	465.00	0.6950	0.6930	0.997169	6.40	.3199E-05
16	475.00	0.7200	0.7254	0.997646	6.56	.3599E-05
17	485.00	0.7650	0.7635	0.995823	6.75	.4464E-05
18	492.00	0.7980	0.7958	0.995673	6.91	.4857E-05
19	496.00	0.8100	0.8175	0.996550	7.01	.5077E-05
20	501.00	0.8500	0.8433	0.996363	7.14	.5312E-05
21	510.00	0.8930	0.8934	0.996626	7.38	.5754E-05
22	515.00	0.9200	0.9237	0.996911	7.52	.5802E-05
23	520.00	0.9530	0.9496	0.997717	7.64	.6291E-05
24	525.00	0.9850	0.9816	0.998313	7.79	.6822E-05
25	530.00	1.0100	1.0175	0.998544	7.96	.7397E-05
26	540.40	1.1050	1.1008	0.998766	8.35	.8783E-05
27	545.00	1.1450	1.1436	0.998807	8.55	.9289E-05
28	550.00	1.1900	1.1931	0.999622	8.78	.9500E-05
29	554.00	1.2330	1.2288	0.995716	8.95	.1034E-04
30	558.00	1.2730	1.2708	0.996205	9.14	.1111E-04
31	563.50	1.3230	1.3339	0.996603	9.44	.1267E-04
32	567.50	1.3950	1.3856	0.997062	9.69	.1408E-04
33	570.50	1.4280	1.4305	0.994176	9.91	.1416E-04
34	573.50	1.4780	1.4780	0.996599	10.14	.1464E-04
35	575.50	1.5100	1.5045	0.996360	10.28	.1489E-04
36	578.50	1.5430	1.5513	0.996052	10.51	.1568E-04
37	580.00	1.5750	1.5773	0.984290	10.64	.1324E-04
38	581.50	1.6000	1.5968	0.982003	10.74	.1273E-04
39	583.00	1.6250	1.6125	0.974455	10.82	.1212E-04
40	588.00	1.6530	1.6606	0.985495	11.08	.9906E-05
41	590.00	1.6780	1.6765	0.994370	11.16	.1040E-04
42	593.00	1.7130	1.7080	0.998335	11.33	.1194E-04
43	596.00	1.7430	1.7468	0.998080	11.54	.1436E-04
44	600.00	1.8080	1.8087	0.999203	11.88	.1784E-04
45	602.50	1.8550	1.8554	0.999563	12.15	.2137E-04
46	604.00	1.8900	1.8890	0.999322	12.35	.2259E-04
47	605.00	1.9100	1.9131	0.995345	12.49	.2121E-04
48	606.00	1.9400	1.9364	0.997794	12.63	.2153E-04
49	607.00	1.9600	1.9555	0.996013	12.75	.2066E-04
50	609.00	1.9930	1.9942	0.996538	12.98	.1989E-04
51	611.00	2.0300	2.0328	0.998981	13.23	.1969E-04
52	613.00	2.0750	2.0716	0.996054	13.48	.2255E-04
53	614.50	2.1080	2.1067	0.995457	13.72	.2402E-04
54	616.00	2.1350	2.1445	0.992907	13.98	.2459E-04
55	617.50	2.1930	2.1829	0.989655	14.25	.2396E-04
56	618.50	2.2100	2.2078	0.987258	14.43	.2524E-04
57	619.50	2.2300	2.2347	0.985746	14.62	.2439E-04
58	620.50	2.2500	2.2541	0.991467	14.77	.2350E-04
59	621.50	2.2880	2.2790	0.993018	14.96	.2554E-04
60	622.50	2.3000	2.3066	0.992530	15.18	.2607E-04
61	623.50	2.3330	2.3327	0.992467	15.38	.2704E-04
62	624.50	2.3650	2.3588	0.993469	15.60	.2650E-04
63	625.50	2.3850	2.3879	0.997465	15.84	.2782E-04
64	626.50	2.4180	2.4141	0.997964	16.07	.2757E-04
65	627.50	2.4400	2.4393	0.994117	16.29	.3057E-04
66	628.50	2.4700	2.4724	0.993136	16.59	.3268E-04
67	629.50	2.5000	2.5046	0.994168	16.89	.3569E-04
68	630.50	2.5530	2.5438	0.993920	17.28	.3848E-04
69	631.50	2.5780	2.5849	0.991707	17.69	.3570E-04
70	632.00	2.6080	2.6042	0.991995	17.90	.3549E-04
71	632.50	2.6250	2.6185	0.989094	18.05	.3470E-04
72	633.50	2.6480	2.6541	0.987942	18.45	.3751E-04
73	634.00	2.6700	2.6709	0.995661	18.64	.3820E-04
74	634.50	2.6950	2.6912	0.994290	18.88	.3957E-04
75	635.00	2.7150	2.7143	0.999274	19.15	.4136E-04
76	635.50	2.7330	2.7344	0.999207	19.40	.3957E-04
77	636.00	2.7530	2.7530	0.999725	19.64	.3821E-04
78	636.50	2.7750	2.7731	0.998393	19.90	.3627E-04
79	637.00	2.7900	2.7906	0.997801	20.14	.3523E-04
80	637.50	2.8100	2.8052	0.991582	20.34	.3445E-04
81	638.50	2.8350	2.8384	0.993817	20.81	.3918E-04
82	639.00	2.8550	2.8585	0.992625	21.11	.4043E-04
83	639.50	2.8830	2.8786	0.992563	21.41	.4673E-04
84	640.00	2.9080	2.9049	0.993649	21.83	.5179E-04
85	640.50	2.9230	2.9318	0.994201	22.28	.5471E-04
86	641.00	2.9650	2.9586	0.995285	22.74	.5871E-04
87	641.50	2.9900	2.9887	0.995872	23.29	.6571E-04
88	642.00	3.0200	3.0248	0.996258	23.99	.7147E-04
89	642.50	3.0600	3.0595	0.997686	24.71	.7496E-04
90	643.00	3.1050	3.0991	0.990973	25.60	.9282E-04
91	643.30	3.1230	3.1272	0.987411	26.28	.1099E-03
92	643.60	3.1480	3.1619	0.871049	27.18	.2062E-03
93	643.90	3.2050				
94	644.00	3.2230				
95	644.10	3.3530				

* - DATA VIOLATES SIZE REQUIREMENTS

TABLE B41

Fatigue Crack Growth Rate Data Associated with Figure B18

Seven Point Incremental Polynomial Method per ASTM E647

04-18-1989

Specimen Number: 86-131-63-LT-2 Specimen Type: CCT

B= 0.0630 in W= 3.7500 in An= 0.0000

Pmax= 2.717 kips Pmin= 1.359 kips

R= 0.50 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	Ameas*2	Areg	MCC	Delta K	da/dN
1	0.00	0.2600				
2	50.00	0.3000				
3	100.00	0.3530				
4	125.00	0.3830	0.3887	0.990617	4.52	.1843E-05
5	150.00	0.4230	0.4349	0.989845	4.79	.2577E-05
6	175.00	0.5000	0.5007	0.998443	5.15	.3595E-05
7	185.00	0.5330	0.5367	0.999305	5.35	.4148E-05
8	200.00	0.6100	0.6050	0.999153	5.70	.4867E-05
9	210.00	0.6530	0.6563	0.998918	5.95	.5385E-05
10	220.00	0.7150	0.7135	0.998785	6.22	.5932E-05
11	225.00	0.7400	0.7418	0.999142	6.36	.6542E-05
12	230.00	0.7750	0.7758	0.998461	6.52	.7239E-05
13	235.00	0.8100	0.8114	0.998684	6.68	.7745E-05
14	240.00	0.8530	0.8528	0.998576	6.87	.8718E-05
15	243.00	0.8830	0.8796	0.998185	7.00	.9024E-05
16	246.00	0.9030	0.9077	0.998086	7.12	.9546E-05
17	249.00	0.9400	0.9362	0.998115	7.25	.1002E-04
18	252.00	0.9650	0.9665	0.998529	7.39	.1064E-04
19	255.00	1.0000	1.0011	0.998760	7.54	.1121E-04
20	258.00	1.0350	1.0349	0.998806	7.69	.1135E-04
21	261.00	1.0730	1.0698	0.998556	7.85	.1213E-04
22	264.00	1.1050	1.1065	0.998423	8.01	.1236E-04
23	267.00	1.1400	1.1435	0.998380	8.18	.1292E-04
24	270.00	1.1880	1.1823	0.998395	8.35	.1402E-04
25	272.00	1.2080	1.2119	0.997518	8.48	.1423E-04
26	274.00	1.2400	1.2415	0.997549	8.62	.1455E-04
27	276.00	1.2750	1.2688	0.996671	8.74	.1530E-04
28	278.00	1.2980	1.3019	0.996855	8.89	.1602E-04
29	280.00	1.3300	1.3334	0.997256	9.03	.1652E-04
30	282.00	1.3730	1.3674	0.996721	9.19	.1677E-04
31	284.00	1.4000	1.4027	0.997969	9.35	.1771E-04
32	286.00	1.4400	1.4385	0.997957	9.52	.1777E-04
33	288.00	1.4700	1.4724	0.998630	9.68	.1800E-04
34	290.00	1.5130	1.5104	0.998888	9.86	.1857E-04
35	292.00	1.5450	1.5473	0.998994	10.04	.1875E-04
36	294.00	1.5880	1.5839	0.996335	10.21	.2041E-04
37	296.00	1.6230	1.6239	0.997751	10.41	.2170E-04
38	298.00	1.6630	1.6693	0.997423	10.64	.2358E-04
39	300.00	1.7250	1.7175	0.997538	10.89	.2657E-04
40	301.00	1.7450	1.7455	0.997260	11.03	.2855E-04
41	302.00	1.7700	1.7756	0.996566	11.19	.2921E-04
42	303.00	1.8050	1.8036	0.997005	11.34	.2982E-04
43	304.00	1.8400	1.8362	0.998479	11.52	.3125E-04
44	305.00	1.8650	1.8686	0.999097	11.70	.3143E-04
45	306.00	1.9000	1.8990	0.999234	11.87	.3071E-04
46	307.00	1.9300	1.9288	0.999243	12.04	.3089E-04
47	308.00	1.9600	1.9607	0.999484	12.22	.3143E-04
48	309.00	1.9900	1.9912	0.999787	12.40	.3161E-04
49	310.00	2.0250	2.0231	0.999799	12.59	.3250E-04
50	311.00	2.0550	2.0552	0.999180	12.79	.3446E-04
51	312.00	2.0900	2.0897	0.999112	13.01	.3714E-04
52	313.00	2.1250	2.1271	0.999767	13.25	.4028E-04
53	314.00	2.1700	2.1695	0.999729	13.53	.4407E-04
54	314.70	2.2030	2.2016	0.999659	13.75	.4622E-04
55	315.40	2.2350	2.2358	0.999969	13.99	.4806E-04
56	316.10	2.2700	2.2697	0.999954	14.24	.4939E-04
57	316.80	2.3050	2.3049	0.999901	14.50	.5031E-04
58	317.50	2.3400	2.3400	0.999582	14.77	.5245E-04
59	318.20	2.3780	2.3766	0.999600	15.06	.5495E-04
60	318.90	2.4130	2.4143	0.998024	15.37	.6144E-04
61	319.60	2.4580	2.4585	0.998082	15.74	.6758E-04
62	320.10	2.4900	2.4929	0.998029	16.04	.7318E-04
63	320.60	2.5380	2.5316	0.996890	16.40	.7474E-04
64	320.90	2.5530	2.5546	0.992632	16.62	.8272E-04
65	321.20	2.5800	2.5804	0.990337	16.87	.8318E-04
66	321.50	2.5980	2.6040	0.990766	17.11	.8393E-04
67	321.80	2.6400	2.6315	0.993337	17.39	.8897E-04
68	322.10	2.6550	2.6572	0.992270	17.67	.9452E-04
69	322.40	2.6850	2.6870	0.992819	17.99	.9881E-04
70	322.70	2.7130	2.7145	0.997084	18.31	.1021E-03
71	323.00	2.7530	2.7485	0.998727	18.71	.1126E-03
72	323.30	2.7800	2.7810	0.991772	19.12	.1322E-03
73	323.60	2.8200	2.8216	0.988786	19.65	.1689E-03
74	323.80	2.8450				
75	324.00	2.8980				
76	324.10	2.9300				

* - DATA VIOLATES SIZE REQUIREMENTS

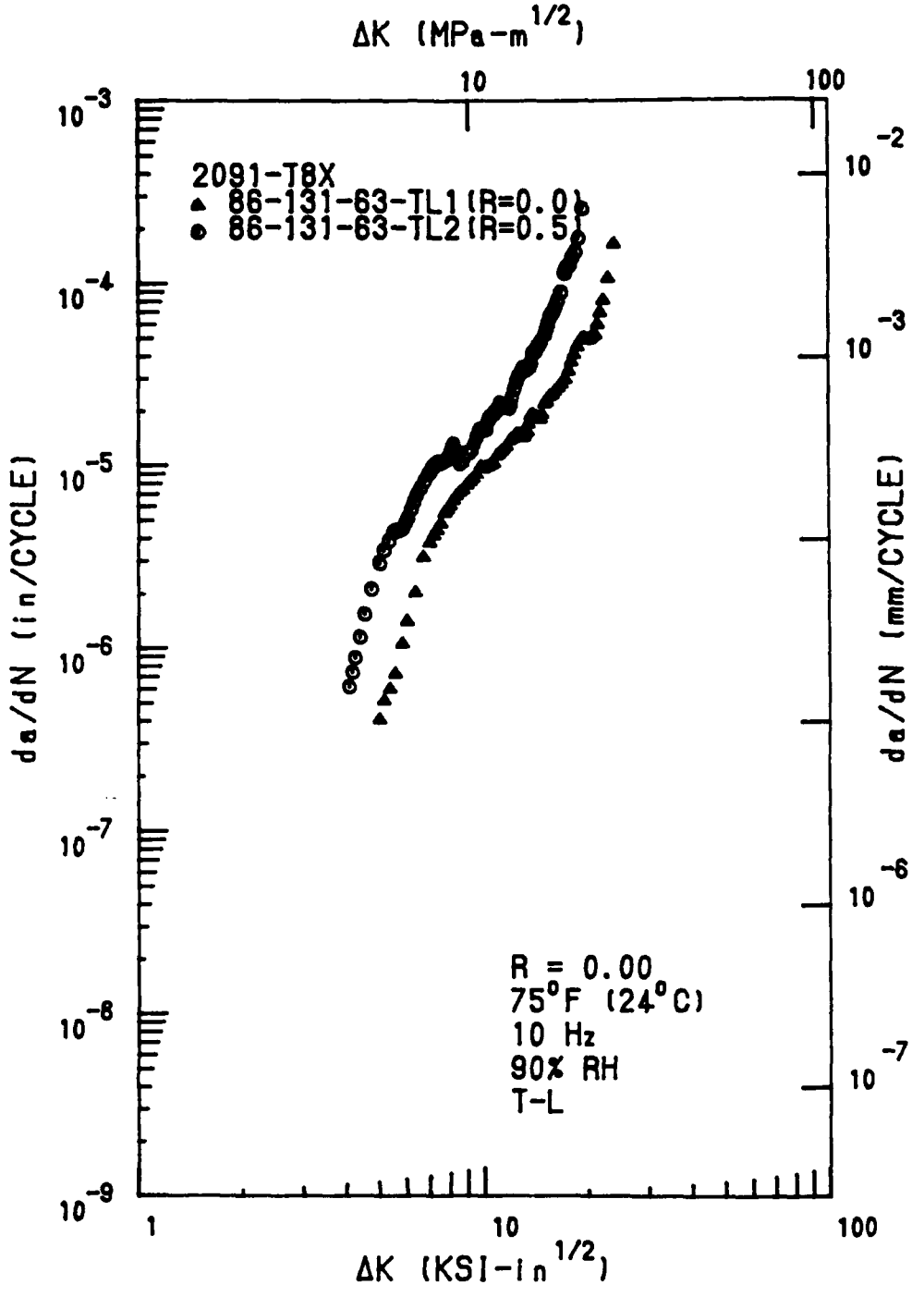


Figure B19 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.063" Sheet (T-L Orientation). Grumman.

TABLE B42

Fatigue Crack Growth Rate Data Associated with Figure B19

Seven Point Incremental Polynomial Method per ASTM E647

04-18-1989

Specimen Number: 86-131-63-TL-1 Specimen Type: CCT

B= 0.0620 in W= 3.7500 in An= 0.0000

Pmax= 1.543 kips Pmin= 0.000 kips

R= 0.00 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	Amean*2	Area	MCC	Delta K	da/dN
1	0.00	0.3100				
2	25.00	0.3200				
3	100.00	0.3380				
4	150.00	0.3550	0.3575	0.997306	5.00	.4042E-06
5	200.00	0.3830	0.3776	0.993947	5.14	.5158E-06
6	250.00	0.4030	0.4060	0.992170	5.34	.5963E-06
7	300.00	0.4330	0.4373	0.992845	5.55	.7226E-06
8	350.00	0.4850	0.4731	0.978160	5.78	.1063E-05
9	380.00	0.4950	0.5038	0.978526	5.97	.1405E-05
10	420.00	0.5450	0.5636	0.984582	6.33	.2022E-05
11	450.00	0.6280	0.6256	0.998830	6.69	.3133E-05
12	465.00	0.6750	0.6764	0.999009	6.98	.3785E-05
13	472.50	0.7000	0.7058	0.998718	7.14	.4130E-05
14	480.00	0.7400	0.7364	0.998561	7.31	.4429E-05
15	487.50	0.7730	0.7723	0.998781	7.51	.4808E-05
16	495.00	0.8100	0.8096	0.996023	7.71	.5481E-05
17	500.00	0.8330	0.8361	0.997306	7.85	.5733E-05
18	505.00	0.8630	0.8662	0.996744	8.01	.6037E-05
19	510.00	0.9050	0.8979	0.997061	8.17	.6471E-05
20	515.00	0.9300	0.9319	0.997842	8.35	.6850E-05
21	520.00	0.9630	0.9658	0.997879	8.53	.7164E-05
22	525.00	1.0030	1.0013	0.998830	8.71	.7343E-05
23	530.00	1.0400	1.0409	0.999660	8.91	.7807E-05
24	535.00	1.0830	1.0806	0.999620	9.12	.8150E-05
25	540.00	1.1200	1.1211	0.999637	9.33	.8492E-05
26	545.00	1.1630	1.1642	0.999639	9.55	.8987E-05
27	550.00	1.2100	1.2094	0.999782	9.78	.9903E-05
28	555.00	1.2400	1.2409	0.996330	9.95	.9629E-05
29	556.00	1.2700	1.2708	0.996084	10.10	.9817E-05
30	559.00	1.3080	1.3009	0.995698	10.26	.9845E-05
31	562.00	1.3230	1.3292	0.994930	10.41	.1004E-04
32	565.00	1.3600	1.3588	0.995563	10.56	.1017E-04
33	568.00	1.3880	1.3890	0.996453	10.72	.1035E-04
34	571.00	1.4250	1.4221	0.998072	10.90	.1135E-04
35	574.00	1.4550	1.4560	0.998515	11.09	.1152E-04
36	577.00	1.4880	1.4920	0.998615	11.28	.1194E-04
37	580.00	1.5330	1.5278	0.998745	11.48	.1230E-04
38	583.00	1.5650	1.5662	0.999087	11.69	.1279E-04
39	586.00	1.6030	1.6035	0.997579	11.90	.1368E-04
40	589.00	1.6450	1.6441	0.997764	12.14	.1409E-04
41	592.00	1.6850	1.6889	0.997438	12.40	.1484E-04
42	595.00	1.7430	1.7349	0.996711	12.67	.1483E-04
43	596.50	1.7550	1.7580	0.996093	12.81	.1468E-04
44	598.00	1.7800	1.7808	0.995458	12.95	.1445E-04
45	599.50	1.8000	1.7993	0.997716	13.07	.1429E-04
46	601.00	1.8230	1.8228	0.998960	13.21	.1495E-04
47	602.50	1.8430	1.8442	0.998879	13.35	.1540E-04
48	604.00	1.8700	1.8670	0.998066	13.49	.1681E-04
49	605.50	1.8900	1.8920	0.998786	13.65	.1867E-04
50	607.00	1.9200	1.9240	0.989993	13.86	.1898E-04
51	608.50	1.9550	1.9547	0.989295	14.07	.1864E-04
52	610.00	1.9930	1.9839	0.992751	14.27	.1857E-04
53	611.50	2.0050	2.0094	0.989681	14.45	.1802E-04
54	613.00	2.0200	2.0328	0.992576	14.61	.1807E-04
55	614.50	2.0600	2.0583	0.998435	14.79	.1907E-04
56	616.00	2.0900	2.0902	0.999804	15.02	.2188E-04
57	617.50	2.1250	2.1264	0.996662	15.29	.2240E-04
58	619.00	2.1600	2.1597	0.995437	15.55	.2400E-04
59	620.50	2.2030	2.1976	0.995018	15.85	.2450E-04
60	622.00	2.2250	2.2339	0.994919	16.14	.2552E-04
61	623.50	2.2800	2.2721	0.995460	16.46	.2671E-04
62	625.00	2.3080	2.3122	0.995932	16.80	.2812E-04
63	626.50	2.3580	2.3583	0.996982	17.22	.2956E-04
64	628.00	2.4030	2.4002	0.996686	17.61	.3290E-04
65	629.00	2.4350	2.4346	0.996156	17.94	.3688E-04
66	630.00	2.4630	2.4702	0.998118	18.29	.4064E-04
67	631.00	2.5150	2.5122	0.997357	18.73	.4472E-04
68	632.00	2.5630	2.5601	0.997239	19.25	.4907E-04
69	632.50	2.5880	2.5872	0.999171	19.56	.4962E-04
70	633.00	2.6080	2.6116	0.998643	19.84	.4867E-04
71	633.50	2.6380	2.6361	0.998345	20.14	.4900E-04
72	634.00	2.6620	2.6607	0.998364	20.44	.4929E-04
73	634.50	2.6830	2.6853	0.997987	20.75	.5086E-04
74	635.00	2.7100	2.7093	0.999505	21.07	.5197E-04
75	635.50	2.7350	2.7337	0.996279	21.40	.5957E-04
76	636.00	2.7650	2.7646	0.997563	21.84	.6900E-04
77	636.50	2.7950	2.8000	0.998700	22.36	.8080E-04
78	637.00	2.8480	2.8411	0.992191	23.00	.1062E-03
79	637.50	2.8930	2.8992	0.969857	23.98	.1641E-03
80	637.80	2.9300				
81	638.10	3.0000				
82	638.20	3.0700				

* - DATA VIOLATES SIZE REQUIREMENTS

TABLE B43

Fatigue Crack Growth Rate Data Associated with Figure B19

Seven Point Incremental Polynomial Method per ASTM E647

04-18-1989

Specimen Number: 86-131-63-TL-2 Specimen Type: CCT

B= 0.0640 in W= 3.7510 in An= 0.0000

Pmax= 2.485 kips Pmin= 1.243 kips

R= 0.50 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	Ameas*2	Areg	MCC	Delta K	da/dN
1	0.00	0.3500				
2	25.00	0.3600				
3	50.00	0.3730				
4	75.00	0.3880	0.3875	0.996996	4.06	.6157E-06
5	100.00	0.4050	0.4029	0.996268	4.15	.7386E-06
6	125.00	0.4200	0.4215	0.997651	4.24	.8900E-06
7	150.00	0.4430	0.4429	0.995934	4.35	.1159E-05
8	175.00	0.4750	0.4729	0.996848	4.50	.1546E-05
9	200.00	0.5100	0.5151	0.997023	4.71	.2104E-05
10	225.00	0.5700	0.5737	0.998097	4.98	.2934E-05
11	275.00	0.6030	0.6026	0.999928	5.12	.3429E-05
12	245.00	0.6380	0.6388	0.999824	5.28	.3846E-05
13	255.00	0.6800	0.6797	0.999722	5.46	.4306E-05
14	260.00	0.7030	0.7018	0.999310	5.55	.4402E-05
15	265.00	0.7230	0.7250	0.999012	5.65	.4406E-05
16	270.00	0.7500	0.7475	0.998882	5.75	.4471E-05
17	275.00	0.7700	0.7691	0.998182	5.84	.4600E-05
18	280.00	0.7900	0.7916	0.997650	5.93	.4907E-05
19	285.00	0.8150	0.8156	0.999651	6.03	.5200E-05
20	290.00	0.8430	0.8429	0.999703	6.15	.5779E-05
21	295.00	0.8750	0.8737	0.999810	6.27	.6343E-05
22	300.00	0.9050	0.9063	0.999701	6.40	.6943E-05
23	305.00	0.9430	0.9422	0.999742	6.55	.7513E-05
24	310.00	0.9800	0.9809	0.999792	6.71	.8188E-05
25	315.00	1.0250	1.0239	0.999809	6.88	.8914E-05
26	318.00	1.0500	1.0510	0.999818	6.99	.9294E-05
27	321.00	1.0800	1.0798	0.999856	7.10	.9743E-05
28	324.00	1.1100	1.1097	0.999736	7.22	.1000E-04
29	327.00	1.1400	1.1405	0.999865	7.35	.1039E-04
30	330.00	1.1730	1.1730	0.998642	7.48	.1023E-04
31	333.00	1.2030	1.2032	0.997968	7.60	.1042E-04
32	336.00	1.2380	1.2342	0.997500	7.73	.1065E-04
33	339.00	1.2600	1.2657	0.997400	7.85	.1089E-04
34	342.00	1.3000	1.2986	0.996948	7.99	.1172E-04
35	343.50	1.3180	1.3157	0.996863	8.06	.1213E-04
36	345.00	1.3330	1.3354	0.997255	8.14	.1314E-04
37	346.50	1.3550	1.3566	0.990015	8.23	.1226E-04
38	348.00	1.3730	1.3754	0.993033	8.30	.1200E-04
39	349.50	1.4000	1.3919	0.992607	8.37	.1153E-04
40	352.50	1.4200	1.4215	0.992417	8.50	.1027E-04
41	355.50	1.4480	1.4490	0.993918	8.61	.1052E-04
42	358.00	1.4750	1.4755	0.995882	8.72	.1060E-04
43	360.50	1.5030	1.5040	0.997080	8.85	.1163E-04
44	363.00	1.5400	1.5356	0.995819	8.98	.1176E-04
45	365.50	1.5600	1.5657	0.996190	9.11	.1170E-04
46	368.00	1.6000	1.5935	0.994257	9.24	.1201E-04
47	370.50	1.6200	1.6204	0.993010	9.35	.1316E-04
48	373.00	1.6500	1.6554	0.991897	9.51	.1434E-04
49	375.50	1.6900	1.6909	0.993019	9.67	.1554E-04
50	377.50	1.7250	1.7259	0.993942	9.84	.1579E-04
51	379.00	1.7480	1.7517	0.995677	9.96	.1578E-04
52	380.50	1.7750	1.7747	0.993828	10.07	.1567E-04
53	382.00	1.7950	1.7945	0.997852	10.16	.1605E-04
54	383.50	1.8200	1.8206	0.998253	10.29	.1762E-04
55	385.00	1.8450	1.8475	0.998664	10.42	.1845E-04
56	386.50	1.8800	1.8782	0.997597	10.57	.1890E-04
57	388.00	1.9080	1.9071	0.997961	10.72	.1936E-04
58	389.50	1.9380	1.9354	0.996534	10.87	.2014E-04
59	391.00	1.9600	1.9642	0.998205	11.02	.2055E-04
60	392.50	1.9950	1.9953	0.998491	11.18	.2206E-04
61	394.00	2.0330	2.0312	0.993759	11.38	.2125E-04
62	395.00	2.0530	2.0548	0.998270	11.51	.2132E-04
63	396.00	2.0800	2.0744	0.993557	11.62	.2109E-04
64	398.00	2.1100	2.1135	0.994307	11.85	.2070E-04
65	399.00	2.1300	2.1336	0.995018	11.96	.2152E-04
66	400.00	2.1600	2.1541	0.996854	12.09	.2366E-04
67	401.00	2.1780	2.1796	0.997225	12.24	.2618E-04
68	402.00	2.2030	2.2060	0.997488	12.40	.2897E-04
69	403.00	2.2380	2.2354	0.997858	12.59	.3095E-04
70	404.00	2.2680	2.2702	0.997836	12.82	.3265E-04
71	405.00	2.3080	2.3042	0.997862	13.04	.3430E-04
72	405.70	2.3280	2.3285	0.996510	13.21	.3330E-04
73	406.40	2.3480	2.3517	0.994995	13.37	.3452E-04
74	407.10	2.3800	2.3748	0.995735	13.54	.3434E-04
75	407.80	2.3950	2.3993	0.995985	13.71	.3658E-04
76	408.50	2.4280	2.4238	0.993548	13.90	.4117E-04
77	409.20	2.4500	2.4541	0.991723	14.13	.4250E-04
78	409.90	2.4830	2.4876	0.993210	14.39	.4527E-04
79	410.60	2.5300	2.5191	0.991491	14.65	.4781E-04
80	411.40	2.5550	2.5597	0.990666	15.00	.5196E-04
81	411.80	2.5730	2.5795	0.989616	15.17	.5557E-04
82	412.20	2.6030	2.5994	0.997057	15.35	.5970E-04
83	412.60	2.6280	2.6271	0.998782	15.61	.6563E-04
84	413.00	2.6530	2.6548	0.999450	15.87	.6875E-04
85	413.40	2.6830	2.6805	0.998470	16.13	.7330E-04
86	413.80	2.7100	2.7104	0.998768	16.43	.7982E-04
87	414.20	2.7400	2.7433	0.998846	16.78	.8896E-04
88	414.60	2.7830	2.7799	0.994921	17.19	.1139E-03
89	414.80	2.8000	2.8030	0.994213	17.46	.1217E-03
90	415.00	2.8230	2.8289	0.992041	17.77	.1262E-03
91	415.20	2.8650	2.8549	0.991387	18.10	.1377E-03
92	415.40	2.8830	2.8846	0.992583	18.49	.1482E-03
93	415.60	2.9080	2.9133	0.982581	18.88	.1753E-03
94	415.80	2.9480	2.9465	0.990256	19.36	.2562E-03
95	415.90	2.9630				
96	416.00	3.0030				
97	416.10	3.0500				

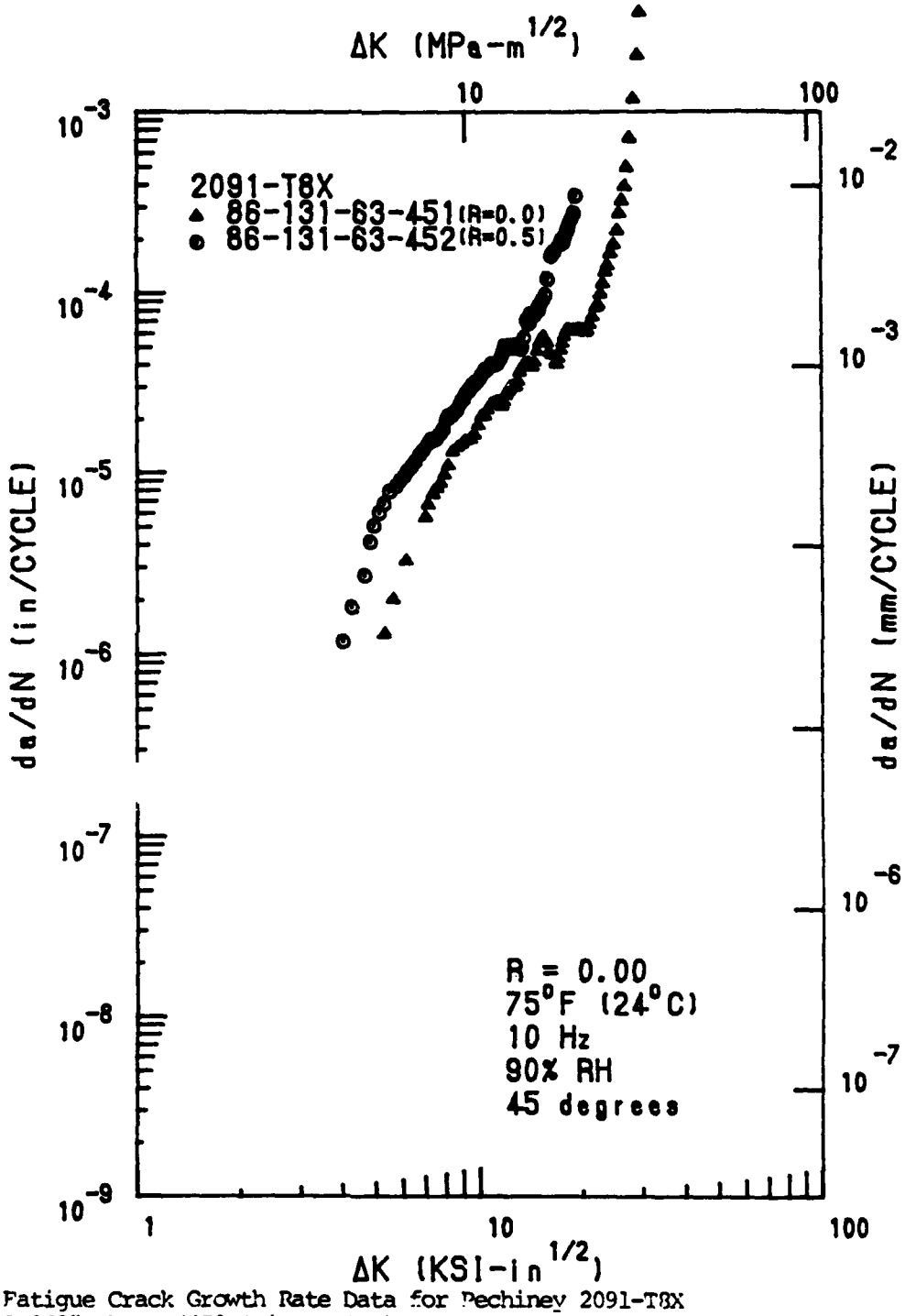


Figure B20 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.063" Sheet (45° Orientation). Grumman.

TABLE B44

Fatigue Crack Growth Rate Data Associated with Figure B20

Seven Point Incremental Polynomial Method per ASTM E647

05-22-1989

Specimen Number: 86-131-63-45-1 Specimen Type: CCT

B= 0.0660 in W= 3.7510 in An= 0.0000

Pmax= 22028.000 lbs Pmin= 0.000 lbs

R= 0.00 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	2*Amess	Areg	MCC	Delta K	da/dN
1	0.00	0.2180				
2	25.00	0.2300				
3	50.00	0.2500				
4	75.00	0.2700	0.2616	0.959184	5.27	.1294E-05
5	100.00	0.2900	0.2946	0.973372	5.59	.2010E-05
6	125.00	0.3300	0.3483	0.985536	6.09	.3269E-05
7	150.00	0.4400	0.4488	0.994183	6.94	.5636E-05
8	155.00	0.4630	0.4675	0.999218	7.06	.6644E-05
9	158.00	0.4980	0.4980	0.999259	7.32	.7605E-05
10	161.00	0.5250	0.5217	0.998077	7.51	.8246E-05
11	164.00	0.5430	0.5466	0.998579	7.69	.8801E-05
12	167.00	0.5730	0.5727	0.998309	7.88	.9786E-05
13	170.00	0.6050	0.6024	0.999191	8.10	.1101E-04
14	173.00	0.6350	0.6375	0.997625	8.35	.1312E-04
15	176.00	0.6780	0.6802	0.994871	8.64	.1386E-04
16	178.50	0.7150	0.7174	0.995112	8.90	.1440E-04
17	180.00	0.7500	0.7412	0.997199	9.06	.1503E-04
18	181.50	0.7900	0.7925	0.995835	9.40	.1541E-04
19	183.00	0.8280	0.8289	0.996228	9.64	.1639E-04
20	184.50	0.8680	0.8693	0.999888	9.90	.1844E-04
21	186.00	0.9080	0.9080	0.999880	10.15	.2070E-04
22	187.50	0.9400	0.9408	0.996943	10.36	.2088E-04
23	189.00	0.9750	0.9736	0.996457	10.57	.2258E-04
24	190.50	1.0130	1.0077	0.995792	10.79	.2399E-04
25	192.00	1.0350	1.0444	0.994154	11.02	.2451E-04
26	193.50	1.0850	1.0815	0.992262	11.26	.2478E-04
27	195.00	1.1080	1.1016	0.989862	11.39	.2460E-04
28	196.50	1.1200	1.1241	0.995677	11.53	.2446E-04
29	198.00	1.1400	1.1404	0.997517	11.63	.2344E-04
30	199.50	1.1600	1.1579	0.998591	11.75	.2491E-04
31	201.00	1.1780	1.1795	0.998800	11.88	.2705E-04
32	202.50	1.2000	1.2019	0.998552	12.03	.2808E-04
33	204.00	1.2280	1.2257	0.998295	12.18	.2879E-04
34	205.50	1.2500	1.2495	0.998908	12.33	.2991E-04
35	207.00	1.2730	1.2732	0.998842	12.48	.3031E-04
36	208.50	1.2950	1.2971	0.999189	12.64	.3000E-04
37	210.00	1.3230	1.3218	0.999264	12.80	.3045E-04
38	211.50	1.3480	1.3463	0.998871	12.95	.3246E-04
39	213.00	1.3700	1.3700	0.995063	13.11	.3643E-04
40	214.50	1.3950	1.4000	0.995224	13.31	.3885E-04
41	216.00	1.4330	1.4348	0.989829	13.54	.3993E-04
42	217.50	1.4780	1.4700	0.993598	13.78	.4052E-04
43	219.00	1.5000	1.4990	0.993842	13.97	.4098E-04
44	220.50	1.5200	1.5258	0.993585	14.16	.3899E-04
45	222.00	1.5500	1.5499	0.997633	14.32	.3872E-04
46	223.50	1.5830	1.5784	0.997892	14.52	.4146E-04
47	225.00	1.6050	1.6076	0.993524	14.72	.4756E-04
48	226.50	1.6400	1.6409	0.995385	14.96	.5271E-04
49	228.00	1.6630	1.6682	0.991214	15.15	.5334E-04
50	229.50	1.7050	1.6977	0.994028	15.37	.5777E-04
51	231.00	1.7300	1.7294	0.993192	15.60	.5573E-04
52	232.50	1.7500	1.7570	0.994963	15.81	.5707E-04
53	234.00	1.7880	1.7797	0.994699	15.98	.4795E-04
54	235.50	1.8150	1.8135	0.991526	16.24	.4537E-04
55	237.00	1.8600	1.8690	0.988693	16.67	.4111E-04
56	238.50	1.8880	1.8874	0.989210	16.82	.4022E-04
57	240.00	1.9200	1.9073	0.983457	16.98	.4338E-04
58	241.50	1.9400	1.9498	0.980564	17.32	.4826E-04
59	243.00	1.9680	1.9718	0.988851	17.51	.5270E-04
60	244.50	2.0050	1.9982	0.992493	17.73	.5720E-04
61	246.00	2.0330	2.0342	0.999177	18.04	.6250E-04
62	247.50	2.0650	2.0657	0.999281	18.32	.6250E-04
63	249.00	2.0980	2.0959	0.999583	18.59	.6136E-04
64	250.50	2.1250	2.1269	0.999654	18.88	.6193E-04
65	252.00	2.1580	2.1575	0.999700	19.17	.6157E-04
66	253.50	2.1880	2.1875	0.999509	19.46	.6200E-04
67	255.00	2.2200	2.2208	0.998413	19.79	.6264E-04
68	256.50	2.2500	2.2519	0.998376	20.10	.6193E-04
69	258.00	2.2880	2.2833	0.998488	20.43	.6086E-04
70	259.50	2.3100	2.3119	0.996692	20.73	.6213E-04
71	261.00	2.3450	2.3410	0.994357	21.05	.6690E-04
72	262.50	2.3700	2.3728	0.998241	21.41	.7401E-04
73	264.00	2.4180	2.4214	0.996836	21.98	.8362E-04
74	265.50	2.4550	2.4475	0.995996	22.29	.8598E-04
75	267.00	2.4780	2.4752	0.989855	22.64	.9885E-04
76	268.50	2.5000	2.5032	0.987697	22.99	.1131E-03
77	270.00	2.5280	2.5364	0.994118	23.43	.1311E-03
78	271.50	2.5700	2.5642	0.993360	23.81	.1424E-03
79	273.00	2.6000	2.5957	0.992153	24.25	.1663E-03
80	274.50	2.6280	2.6316	0.991230	24.78	.1858E-03
81	276.00	2.6600	2.6673	0.995760	25.33	.2227E-03
82	277.50	2.6950	2.6892	0.992440	25.67	.2761E-03
83	279.00	2.7150	2.7177	0.992605	26.14	.3253E-03
84	280.50	2.7450	2.7526	0.991360	26.73	.3911E-03
85	282.00	2.7780	2.7705	0.990184	27.05	.4960E-03
86	283.50	2.7930	2.7981	0.952819	27.55	.7184E-03
87	285.00	2.8200	2.8363	0.942371	28.28	.1184E-02
88	286.50	2.8550	2.8749	0.971419	29.07	.2053E-02
89	288.00	2.8980	2.8967	0.957422	29.53	.3542E-02
90	289.50	2.9230				
91	291.00	2.9550				
92	292.50	3.0550				

* - DATA VIOLATES SIZE REQUIREMENTS

TABLE B45

Fatigue Crack Growth Rate Data Associated with Figure B20

Seven Point Incremental Polynomial Method per ASTM E647

05-22-1989

Specimen Number: B6-131-45-63-2 Specimen Type: CCT

B= 0.0640 in W= 3.7480 in An= 0.0000

Fmax= %2948.000 lbs Pmin= %1474.000 lbs

R= 0.50 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 90% RH

PT	CYCLES	2*Amess	Areg	MCC	Delta K	da/dN	
1	0.00	0.2150					
2	25.00	0.2250					
3	50.00	0.2300					
4	100.00	0.2680	0.2665	0.984935	3.99	.1177E-05	
5	125.00	0.2900	0.2977	0.983751	4.22	.1803E-05	
6	150.00	0.3380	0.3518	0.980928	4.59	.2700E-05	
7	160.00	0.3730	0.3788	0.994692	4.77	.4129E-05	
8	165.00	0.4000	0.3987	0.999306	4.90	.5086E-05	
9	170.00	0.4230	0.4242	0.999063	5.06	.5969E-05	
10	175.00	0.4550	0.4558	0.998838	5.25	.6701E-05	
11	180.00	0.4900	0.4901	0.998570	5.45	.7815E-05	
12	185.00	0.5350	0.5327	0.996777	5.69	.8413E-05	
13	188.00	0.5550	0.5589	0.996366	5.84	.9018E-05	
14	191.00	0.5930	0.5868	0.996097	5.99	.9566E-05	
15	194.00	0.6100	0.6150	0.996345	6.14	.1017E-04	
16	197.00	0.6480	0.6473	0.996800	6.31	.1088E-04	
17	200.00	0.6800	0.6792	0.998083	6.48	.1156E-04	
18	203.00	0.7180	0.7175	0.999362	6.68	.1255E-04	
19	206.00	0.7530	0.7546	0.999457	6.86	.1337E-04	
20	209.00	0.7980	0.7961	0.999436	7.07	.1446E-04	
21	211.00	0.8230	0.8253	0.999541	7.21	.1529E-04	
22	213.00	0.8580	0.8582	0.997157	7.37	.1519E-04	
23	215.00	0.8900	0.8886	0.996248	7.52	.1573E-04	
24	217.00	0.9250	0.9206	0.995257	7.68	.1657E-04	
25	219.00	0.9450	0.9524	0.995512	7.83	.1760E-04	
26	221.00	0.9880	0.9878	0.996287	8.00	.1986E-04	
27	222.00	1.0100	1.0072	0.995825	8.09	.2068E-04	
28	223.00	1.0300	1.0311	0.999523	8.21	.2073E-04	
29	224.00	1.0530	1.0513	0.997968	8.30	.2118E-04	
30	225.00	1.0730	1.0720	0.998182	8.40	.2154E-04	
31	226.00	1.0900	1.0938	0.998311	8.51	.2207E-04	
32	227.00	1.1180	1.1158	0.998619	8.61	.2268E-04	
33	228.00	1.1400	1.1392	0.998819	8.72	.2382E-04	
34	229.00	1.1630	1.1637	0.998890	8.84	.2525E-04	
35	230.00	1.1880	1.1887	0.999505	8.96	.2564E-04	
36	231.00	1.2150	1.2149	0.999402	9.08	.2736E-04	
37	232.00	1.2450	1.2437	0.998976	9.22	.2821E-04	
38	233.00	1.2700	1.2723	0.998983	9.36	.2932E-04	
39	234.00	1.3050	1.3017	0.998954	9.50	.3054E-04	
40	235.00	1.3300	1.3330	0.998564	9.66	.3104E-04	
41	236.00	1.3650	1.3651	0.998878	9.81	.3196E-04	
42	237.00	1.4000	1.3962	0.998803	9.97	.3296E-04	
43	238.00	1.4280	1.4302	0.998846	10.14	.3490E-04	
44	239.00	1.4630	1.4641	0.999297	10.31	.3720E-04	
45	240.00	1.5030	1.5033	0.995308	10.50	.3729E-04	
46	240.80	1.5350	1.5350	0.996452	10.67	.3875E-04	
47	241.60	1.5730	1.5663	0.995334	10.83	.4009E-04	
48	242.40	1.5900	1.5984	0.994963	11.00	.3987E-04	
49	243.20	1.6300	1.6301	0.994582	11.17	.3983E-04	
50	243.70	1.6550	1.6491	0.994267	11.27	.4039E-04	
51	244.70	1.6900	1.6929	0.996863	11.50	.4248E-04	
52	245.20	1.7100	1.7118	0.998301	11.61	.4446E-04	
53	245.70	1.7350	1.7336	0.999826	11.72	.4724E-04	
54	246.20	1.7580	1.7588	0.999755	11.87	.5043E-04	
55	246.70	1.7850	1.7865	0.996952	12.03	.5000E-04	
56	247.20	1.8130	1.8116	0.997165	12.17	.4950E-04	
57	247.70	1.8400	1.8355	0.995188	12.31	.5064E-04	
58	248.20	1.8550	1.8603	0.995348	12.46	.4979E-04	
59	248.70	1.8830	1.8843	0.996256	12.60	.5043E-04	
60	249.20	1.9150	1.9103	0.995732	12.76	.5114E-04	
61	249.70	1.9350	1.9387	0.998569	12.93	.5136E-04	
62	250.20	1.9650	1.9629	0.997296	13.08	.5029E-04	
63	250.70	1.9880	1.9868	0.997930	13.23	.4886E-04	
64	251.20	2.0080	2.0115	0.997424	13.39	.5039E-04	
65	251.70	2.0380	2.0346	0.995212	13.54	.5670E-04	
66	252.20	2.0600	2.0639	0.992785	13.74	.7059E-04	
67	252.50	2.0800	2.0866	0.987649	13.89	.6725E-04	
68	252.70	2.1050	2.1014	0.989475	13.99	.6834E-04	
69	252.90	2.1230	2.1166	0.993492	14.10	.7637E-04	
70	253.60	2.1630	2.1649	0.987020	14.44	.7500E-04	
71	254.20	2.2030	2.2097	0.992710	14.77	.8175E-04	
72	254.40	2.2250	2.2260	0.992113	14.89	.8015E-04	
73	254.50	2.2450	2.2350	0.992492	14.96	.8477E-04	
74	255.00	2.2780	2.2787	0.993052	15.30	.9060E-04	
75	255.40	2.3100	2.3130	0.995333	15.57	.9759E-04	
76	255.70	2.3450	2.3424	0.989777	15.81	.1197E-03	
77	256.10	2.3850	2.3951	0.990383	16.26	.1618E-03	
78	256.20	2.4050	2.4105	0.989765	16.40	.1664E-03	
79	256.30	2.4380	2.4279	0.989076	16.55	.1705E-03	
80	256.50	2.4700	2.4705	0.996145	16.95	.1941E-03	
81	256.70	2.5030	2.5060	0.994956	17.29	.1866E-03	
82	256.90	2.5430	2.5411	0.999121	17.64	.1909E-03	
83	257.00	2.5580	2.5604	0.998385	17.83	.2047E-03	
84	257.10	2.5830	2.5811	0.998043	18.05	.2182E-03	
85	257.20	2.6000	2.6018	0.998252	18.27	.2397E-03	
86	257.30	2.6280	2.6281	0.996977	18.56	.2568E-03	*
87	257.40	2.6530	2.6539	0.997210	18.86	.2789E-03	*
88	257.50	2.6880	2.6801	0.987409	19.17	.3464E-03	*
89	257.60	2.7100					
90	257.70	2.7500					
91	257.80	2.8230					

* - DATA VIOLATES SIZE REQUIREMENTS

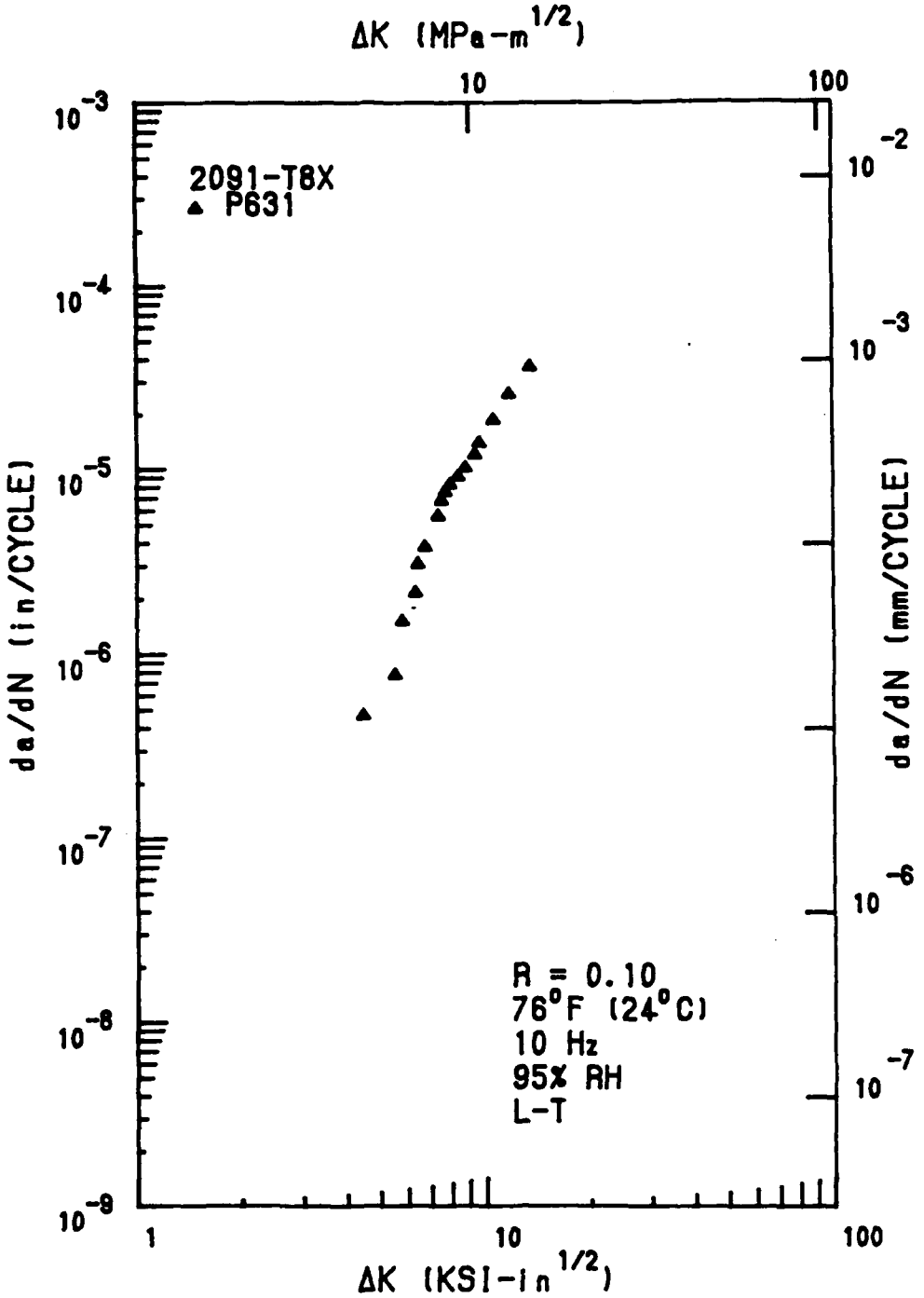


Figure B21 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.063" Sheet (L-T Orientation). Northrop.

TABLE B46

Fatigue Crack Growth Rate Data Associated with Figure B21

Seven Point Incremental Polynomial Method per ASTM E647

06-12-1989

Specimen Number: P6-31 Specimen Type: CCT

B= 0.0630 in W= 3.0030 in An= 0.0000

Pmax= 1.000 kips Pmin= 0.100 kips

R= 0.10 Frequency= 10.00 hz.

Test Temperature= 76 F Environment= 95% RH

PT	CYCLES	Ameas*2	Areg	MCC	Delta K	da/dN
1	0.00	0.2965				
2	250.00	0.3470				
3	902.00	0.5110				
4	982.00	0.5390	0.5372	0.979692	4.46	.4670E-06
5	1392.00	0.7255	0.7817	0.969526	5.50	.7741E-06
6	1492.00	0.8080	0.8460	0.985488	5.77	.1509E-05
7	1564.00	0.9495	0.9801	0.977966	6.32	.2152E-05
8	1582.00	0.9960	1.0023	0.997699	6.42	.3065E-05
9	1607.00	1.0725	1.0806	0.996984	6.74	.3800E-05
10	1640.00	1.2058	1.2184	0.996398	7.34	.5584E-05
11	1647.00	1.2507	1.2571	0.996997	7.51	.6752E-05
12	1654.00	1.3020	1.3027	0.999357	7.72	.7498E-05
13	1660.00	1.3535	1.3522	0.999690	7.95	.8217E-05
14	1670.00	1.4425	1.4389	0.999743	8.37	.9102E-05
15	1679.00	1.5195	1.5208	0.999155	8.79	.1019E-04
16	1689.00	1.6260	1.6260	0.998973	9.36	.1201E-04
17	1694.00	1.6820	1.6767	0.994428	9.65	.1394E-04
18	1704.00	1.8215	1.8279	0.994767	10.61	.1865E-04
19	1712.00	1.9610	1.9842	0.996627	11.78	.2567E-04
20	1718.00	2.1475	2.1678	0.988696	13.50	.3607E-04
21	1719.00	2.1865				
22	1720.00	2.2345				
23	1720.60	2.3095				

* - DATA VIOLATES SIZE REQUIREMENTS

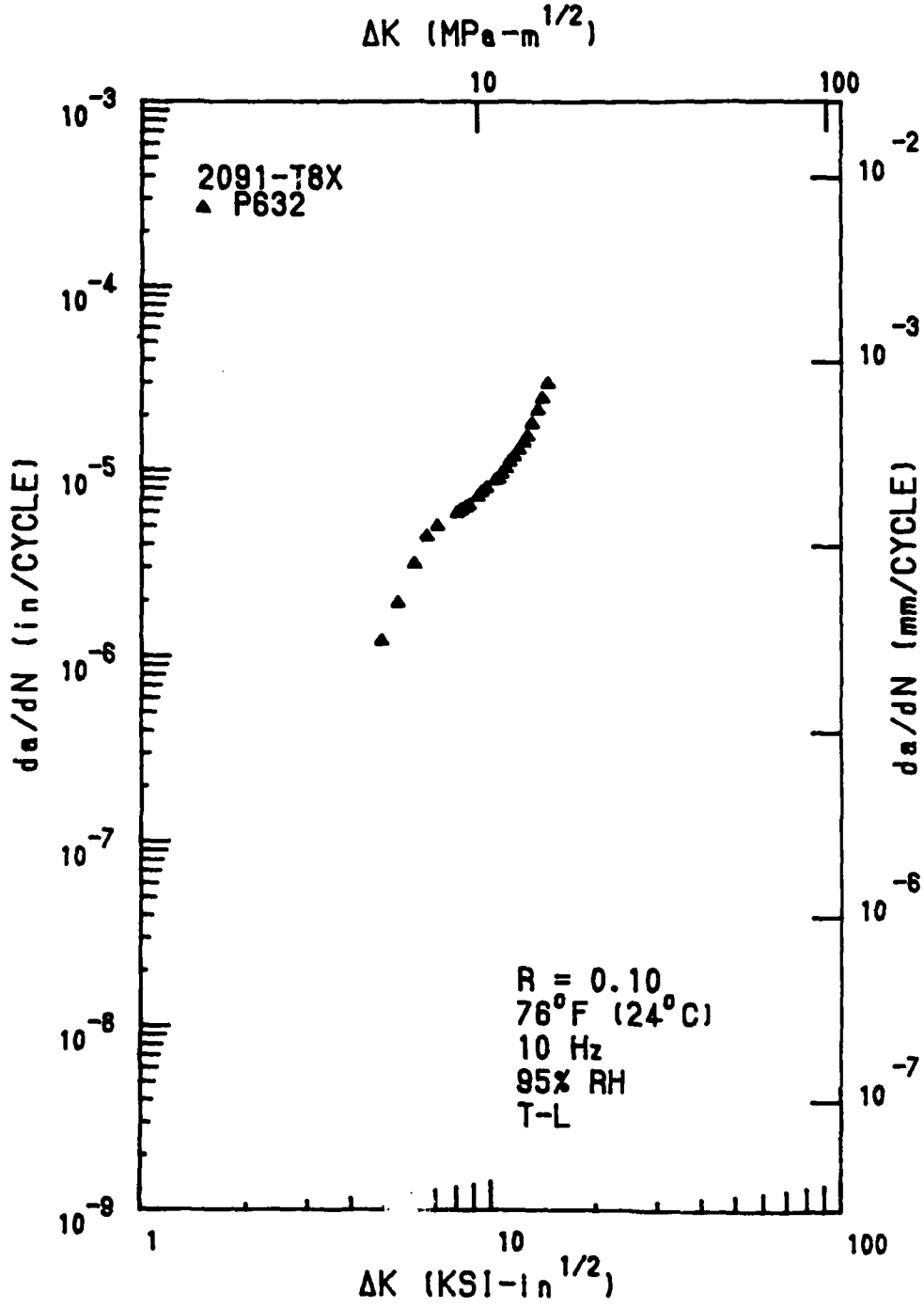


Figure B22 Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.063" Sheet (T-L Orientation). Northrop.

TABLE B47

Fatigue Crack Growth Rate Data Associated with Figure B22

Seven Point Incremental Polynomial Method per ASTM E647

06-12-1989

Specimen Number: P6-32 Specimen Type: CCT

B= 0.0630 in W= 3.0000 in An= 0.0000

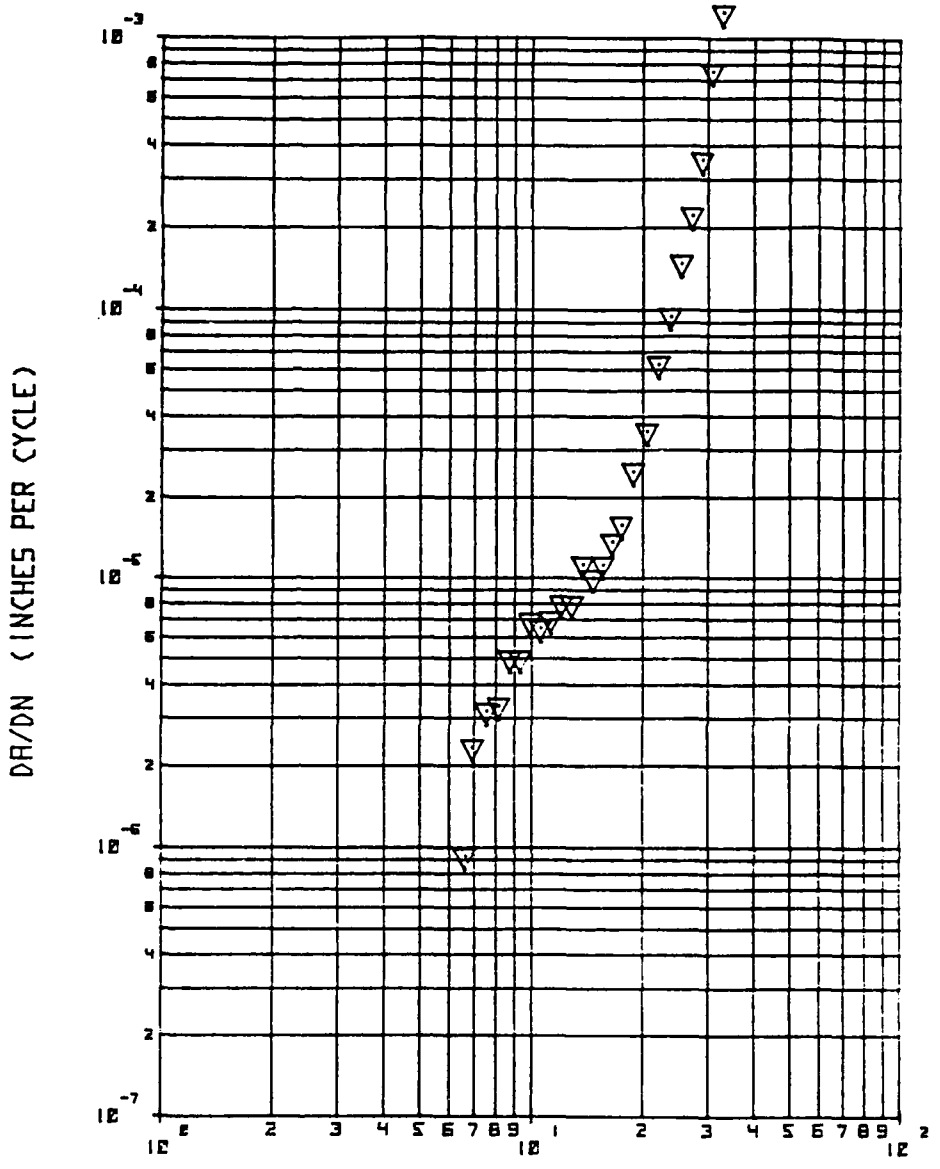
Pmax= 1.200 kips Pmin= 0.120 kips

R= 0.10 Frequency= 10.00 hz.

Test Temperature= 76 F Environment= 95% RH

PT	CYCLES	Ameas*2	Areg	MCC	Delta K	da/dN
1	0.00	0.2160				
2	100.00	0.2345				
3	250.00	0.2775				
4	540.00	0.4165	0.4456	0.939963	4.85	.1207E-05
5	616.00	0.4820	0.5465	0.947477	5.41	.1925E-05
6	671.00	0.6080	0.6655	0.973384	6.03	.3112E-05
7	710.00	0.7745	0.7685	0.999616	6.55	.4418E-05
8	730.40	0.8625	0.8627	0.999633	7.01	.5001E-05
9	766.40	1.0625	1.0626	0.999830	8.01	.5846E-05
10	773.40	1.1040	1.1029	0.999850	8.22	.6080E-05
11	780.40	1.1470	1.1471	0.999943	8.45	.6276E-05
12	787.40	1.1910	1.1902	0.999876	8.67	.6469E-05
13	800.40	1.2755	1.2764	0.999827	9.13	.7192E-05
14	806.40	1.3200	1.3199	0.999956	9.37	.7586E-05
15	812.40	1.3660	1.3665	0.999932	9.64	.7978E-05
16	824.40	1.4690	1.4682	0.999945	10.24	.8820E-05
17	828.40	1.5050	1.5043	0.999889	10.46	.8944E-05
18	832.40	1.5395	1.5404	0.998644	10.69	.9581E-05
19	837.40	1.5885	1.5868	0.998912	10.99	.1028E-04
20	841.40	1.6235	1.6286	0.999322	11.27	.1114E-04
21	845.40	1.6780	1.6755	0.998970	11.59	.1190E-04
22	849.40	1.7260	1.7249	0.998867	11.95	.1293E-04
23	853.40	1.7805	1.7791	0.998746	12.37	.1416E-04
24	856.40	1.8165	1.8204	0.999263	12.70	.1536E-04
25	859.40	1.8675	1.8663	0.997438	13.08	.1796E-04
26	862.40	1.9195	1.9211	0.998984	13.57	.2124E-04
27	864.40	1.9605	1.9649	0.998780	13.98	.2460E-04
28	866.40	2.0200	2.0133	0.997572	14.46	.2974E-04
29	868.40	2.0715				
30	870.40	2.1445				
31	872.40	2.2475				

* - DATA VIOLATES SIZE REQUIREMENTS



Material:	2091-T81
Age:	335°F - 32 hrs
Environment:	Lab air, Room temperature
Orientation:	L-T
Stress Ratio:	0.1
Frequency:	5 Hz

Figure B23 K-increasing Constant Amplitude Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.063" Sheet (L-T Orientation). General Dynamics, TX.

TABLE B48

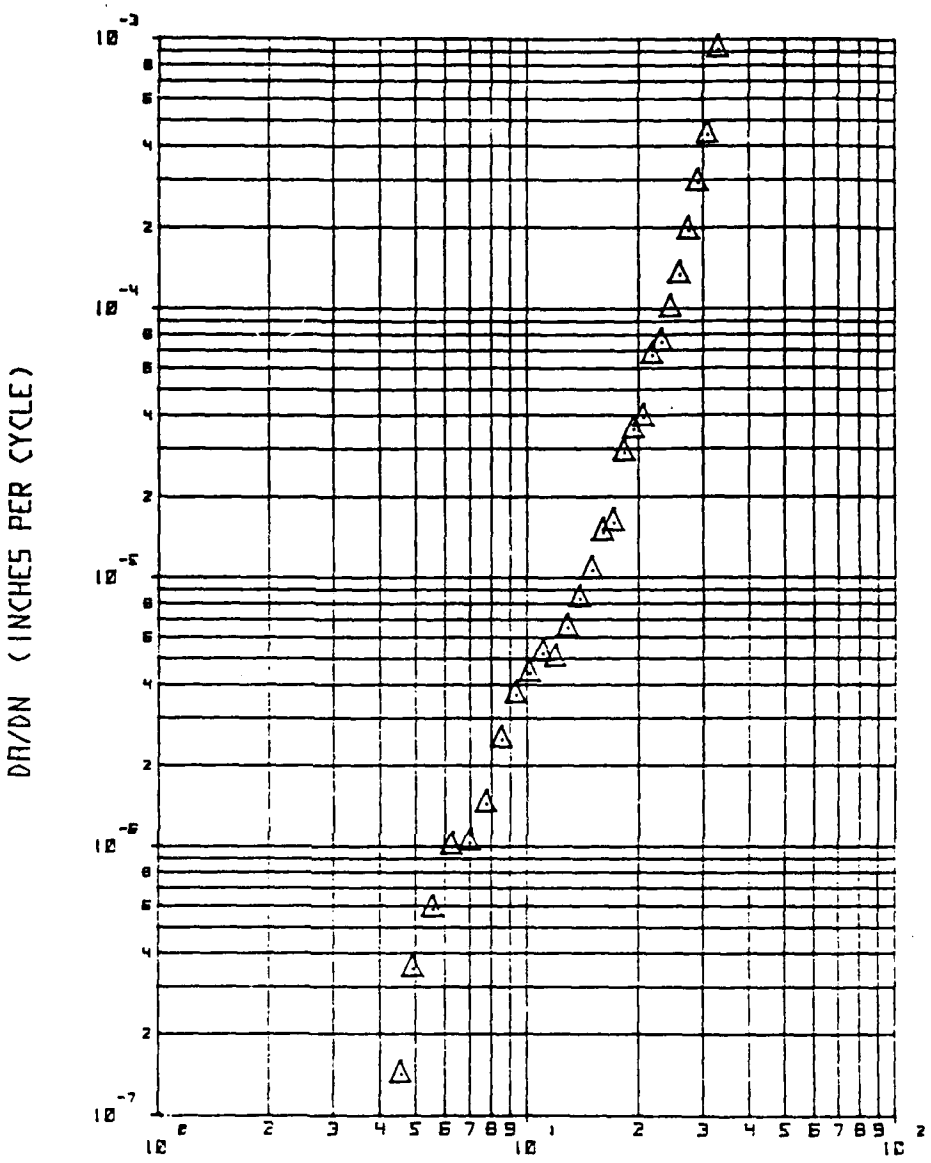
Fatigue Crack Growth Rate Data Associated with Figure B23

CENTER-CRACKED PANEL
S46
2091 LT ORIENTATION
RT

GENERAL DYNAMICS
FORT WORTH DIVISION
2/87

300 CPM
R= 0.1 B= 0.0645 W= 5.996

NO. OF PTS.	TOTAL CYCLES	TOTAL AVG. CRACK LENGTH (IN)	TOTAL DELTA CRACK LENGTH (IN)	LSQ FIT DA/DN (IN/CYC)	CORR. COEFF.	AVG. MAX. LOAD (LBS)	AVG. DEL-K (KSI-SQRT)
2	24195	1.7925	0.0450	9.30E-07	1.000	1600	6.61
2	15000	1.8500	0.0700	2.33E-06	1.000	1650	6.96
2	11000	1.9200	0.0700	3.18E-06	1.000	1750	7.56
2	7500	1.9800	0.0500	3.33E-06	1.000	1850	8.16
2	5000	2.0300	0.0500	5.00E-06	1.000	1950	8.75
2	4000	2.0750	0.0400	5.00E-06	1.000	2050	9.33
2	4000	2.1225	0.0550	6.88E-06	1.000	2150	9.95
2	5000	2.1825	0.0650	6.50E-06	1.000	2250	10.61
2	5000	2.2500	0.0700	7.00E-06	1.000	2350	11.33
2	5000	2.3250	0.0800	8.00E-06	1.000	2450	12.10
2	5000	2.4050	0.0800	8.00E-06	1.000	2550	12.91
2	4000	2.4900	0.0900	1.13E-05	1.000	2650	13.78
2	4000	2.5750	0.0800	1.00E-05	1.000	2750	14.68
2	3566	2.6550	0.0800	1.12E-05	1.000	2850	15.58
2	2920	2.7350	0.0800	1.37E-05	1.000	2950	16.52
2	3000	2.8225	0.0950	1.58E-05	1.000	3050	17.53
2	2000	2.9200	0.1000	2.50E-05	1.000	3200	18.94
2	710	2.9950	0.0500	3.52E-05	1.000	3400	20.56
2	478	3.0500	0.0600	6.28E-05	1.000	3600	22.12
2	290	3.1075	0.0550	9.48E-05	1.000	3800	23.75
2	236	3.1700	0.0700	1.48E-04	1.000	4000	25.45
2	124	3.2325	0.0550	2.22E-04	1.000	4200	27.21
2	99	3.2950	0.0700	3.54E-04	1.000	4400	29.02
2	53	3.3700	0.0800	7.55E-04	1.000	4600	30.99
2	20	3.4350	0.0500	1.25E-03	1.000	4800	32.94
2	20	3.5125	0.1050	2.63E-03	1.000	5000	35.07



Material:	2091-T81 Sheet
Age:	335°F - 32 hrs
Environment:	Lab air, Room temperature
Orientation:	T-L
Stress Ratio:	0.1
Frequency:	5 Hz

Figure B24 K-increasing Constant Amplitude Fatigue Crack Growth Rate Data for Pechiney 2091-T8X 0.063" Sheet (T-L). General Dynamics, TX.

TABLE B49

Fatigue Crack Growth Rate Data Associated with Figure B24

CENTER-CRACKED PANEL
S45
2091 TL ORIENTATION
RT

GENERAL DYNAMICS
FORT WORTH DIVISION
3/87

300 CPM
R= 0.1 B= 0.0642 W= 5.995

NO. OF FTS.	TOTAL CYCLES	TOTAL AVG. CRACK LENGTH (IN)	TOTAL DELTA CRACK LENGTH (IN)	LSQ FIT DA/DN (IN/CYC)	CORR. COEFF.	AVG. MAX. LOAD (LBS)	AVG. DEL-K (KSI-SQRT)
2	150000	1.5563	0.0425	1.42E-07	1.000	1200	4.56
2	50000	1.5950	0.0350	3.50E-07	1.000	1275	4.92
2	30000	1.6300	0.0350	5.83E-07	1.000	1425	5.58
2	30000	1.6775	0.0600	1.00E-06	1.000	1575	6.27
2	20500	1.7288	0.0425	1.04E-06	1.000	1725	7.00
2	20000	1.7788	0.0575	1.44E-06	1.000	1875	7.75
2	11500	1.8363	0.0575	2.50E-06	1.000	2025	8.54
2	7500	1.8925	0.0550	3.67E-06	1.000	2175	9.36
2	6250	1.9475	0.0550	4.40E-06	1.000	2325	10.19
2	6200	2.0075	0.0650	5.24E-06	1.000	2475	11.07
2	5000	2.0650	0.0500	5.00E-06	1.000	2625	11.97
2	5000	2.1225	0.0650	6.50E-06	1.000	2775	12.90
2	4200	2.1900	0.0700	8.33E-06	1.000	2925	13.90
2	4000	2.2675	0.0850	1.06E-05	1.000	3075	14.98
2	1700	2.3350	0.0500	1.47E-05	1.000	3225	16.05
2	2500	2.4000	0.0800	1.60E-05	1.000	3375	17.15
2	1205	2.4750	0.0700	2.90E-05	1.000	3525	18.33
2	813	2.5388	0.0575	3.54E-05	1.000	3675	19.49
2	800	2.5988	0.0625	3.91E-05	1.000	3825	20.66
2	523	2.6650	0.0700	6.69E-05	1.000	3975	21.91
2	400	2.7300	0.0600	7.50E-05	1.000	4125	23.18
2	350	2.7950	0.0700	1.00E-04	1.000	4275	24.49
2	300	2.8700	0.0800	1.33E-04	1.000	4425	25.92
2	200	2.9488	0.0775	1.94E-04	1.000	4575	27.43
2	175	3.0388	0.1025	2.93E-04	1.000	4725	29.09
2	108	3.1375	0.0950	4.40E-04	1.000	4875	30.88
2	79	3.2575	0.1450	9.18E-04	1.000	5025	32.95

APPENDIX C

PECHINEY

2091-T6 PRECISION FORGING

INTRODUCTION

The Pechiney 2091-T6 precision forgings were received the third quarter of 1986. Five participants tested this material; Boeing Commercial Airplane Company, General Dynamics Fort Worth Division, Lockheed Aeronautical Systems Company, Martin Marietta Manned Space Systems and Northrop Corporation. Forging Dimensions are shown in Figure C1.

TESTING

Basic mechanical properties (tension, compression, bearing, etc.) were tested according to ASTM standards, unless otherwise specified.

Constant amplitude fatigue crack growth tests were conducted according to ASTM E647 Standard. The growth rate a-N data that was generated by the participant, Northrop Corporation, was reduced using a seven-point incremental polynomial method. This involves fitting a second-order polynomial (parabola) to sets of seven successive data points. The data are also checked against size requirements per ASTM E647, Section 7.2.

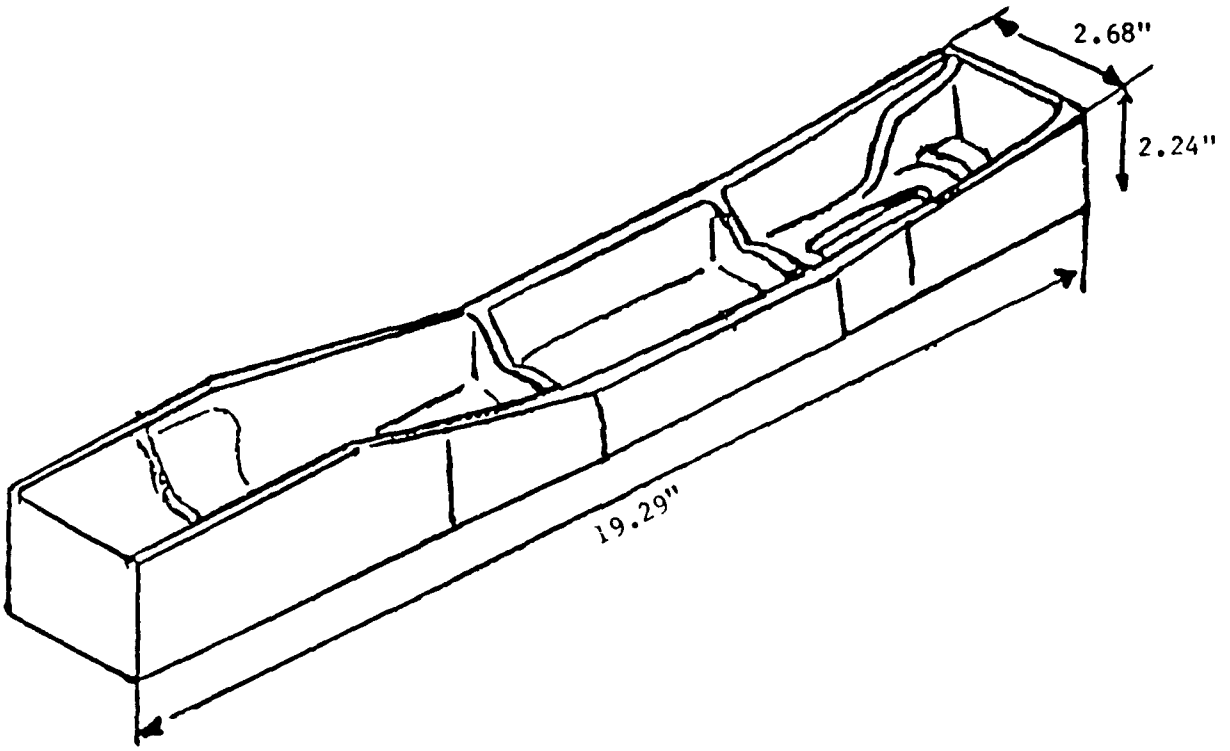


Figure C1 2091-T6 Precision Die Forging Dimensions.

TABLE C1

TENSILE RESULTS AT t/2 LOCATION FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	MODULUS (MSI)	COMMENT
BOEING	RT	LONG	73.6	65.3	4.0			
			77.9	66.5	5.0			
			82.2	72.3	8.0			
NORTHROP	RT	LONG	81.3	69.4	10.0	9.0	11.2	(1),(2)
			82.8	72.1	9.0	7.5	11.4	(2)
			83.1	73.0	8.0	6.4	11.4	(2)
			85.9	76.7	8.0	7.5	11.1	(2)
			80.2	69.8	8.0	7.1	11.5	(2)
			85.0	75.5	8.0	7.4	11.3	(2)
			81.7	72.7	5.0	4.5	11.2	(3)
			81.6	71.8	7.0	5.7	11.3	(3)
			67.1	58.4	3.0	2.0	11.2	(4)
			68.0	56.6	4.0	3.3	11.2	(4)
GENERAL DYNAMICS, TEXAS	RT	LONG	84.4	73.5	6.7			
			84.0	73.0	6.8			
LOCKHEED, GEORGIA	RT	LONG	83.9	72.7	9.0		12.8	
			80.1	68.4	8.0		12.5	
			80.9	68.9	9.0		11.5	
			83.9	72.4	8.0		11.1	
			83.7	72.7	9.0		11.8	
MARTIN MARIETTA, LOUISIANA	RT	LONG	74.6	68.4	2.0	6.0	11.4	
			81.3	68.7	5.0	10.0	11.8	
			77.9	63.2	5.0	10.0	11.8	
		AVERAGE	80.2	69.7	6.8	6.6	11.5	
		STANDARD DEVIATION	5.0	5.0	2.2	2.4	0.5	

(1): INDICATES THAT THE SPECIMEN FAILED OUTSIDE THE GAGE MARKS
(2): SPECIMEN REMOVED FROM THE FORGING BASE
(3): SPECIMEN REMOVED FROM THE FORGING SIDE WALL
(4): SPECIMEN REMOVED FROM THE FORGING END WALL

TABLE C2

TENSILE RESULTS AT t/2 LOCATION FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	MODULUS (MSI)	COMMENT
NORTHROP	RT	L TRANS	66.4				11.2	(1),(2)
			78.6	70.9	5.0		11.4	(2)
			63.8				11.3	(1),(2)
			75.0	68.3	3.0		11.2	(1),(2)
			60.6		1.0		11.2	(1),(2)
			71.5	66.0	2.0		10.8	(1),(2)
			69.2	63.2	2.0		11.3	(4)
			66.1	58.7	2.0		11.1	(4)
		AVERAGE	68.9	65.4	2.5		11.2	
	STANDARD DEVIATION		5.9	4.7	1.4		0.2	

(1): INDICATES THAT THE SPECIMEN FAILED OUTSIDE THE GAGE MARKS
(2): SPECIMEN REMOVED FROM THE FORGING BASE
(3): SPECIMEN REMOVED FROM THE FORGING SIDE WALL
(4): SPECIMEN REMOVED FROM THE FORGING END WALL

TABLE C3

TENSILE RESULTS AT t/2 LOCATION FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	TEST TEMP (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	MODULUS (MSI)	COMMENT
LOCKHEED, GEORGIA	RT	S TRANS	68.7		6.0			
			72.2		6.0			
			66.6		6.0			
			70.9		6.0			
			72.1		6.0			
		AVERAGE	70.1		6.0			
	STANDARD DEVIATION		2.4		0.0			

TABLE C4

COMPRESSION RESULTS AT t/2 LOCATION FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
BOEING	RT	LONG	68.6	
			72.4	
			70.4	
NORTHROP	RT	LONG	67.3	11.7
			73.8	11.6
			75.4	11.8
LOCKHEED, GEORGIA	RT	LONG	67.0	
			62.0	
			64.7	
			62.7	
			65.6	
GENERAL DYNAMICS, TEXAS	RT	LONG	57.7	
MARTIN MARIETTA, LOUISIANA	RT	LONG	73.4	12.2
			64.3	12.1
		AVERAGE	67.5	11.9
		STANDARD DEVIATION	5.1	0.3

NOTE: NORTHROP SPECIMENS TAKEN FROM FORGING SIDE WALL.

TABLE C5

COMPRESSION RESULTS AT t/2 LOCATION FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
MARTIN MARIETTA, LOUISIANA	RT	L TRANS	61.7	12.0
			60.2	12.0
		AVERAGE	61.0	12.0
		STANDARD DEVIATION	1.1	0.0

TABLE C6

AMSLER DOUBLE SHEAR RESULTS FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	L-S	38.6
		39.5
		38.9
LOCKHEED, GEORGIA	L-S	38.7
		40.4
		39.8
	AVERAGE	39.3
	STANDARD DEVIATION	0.7

NOTE: NORTHROP SPECIMENS TAKEN FROM FORGING SIDE WALL.

TABLE C7

AMSLER DOUBLE SHEAR RESULTS FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
NORTHROP	T-S	38.0
		37.1
		35.8
LOCKHEED, GEORGIA	T-S	39.0
		42.4
		38.3
	AVERAGE	38.4
	STANDARD DEVIATION	2.2

NOTE: NORTHROP SPECIMENS TAKEN FROM FORGING SIDE WALL.

TABLE C8

SLOTTED SHEAR RESULTS FOR PECHINEY

2091-T6 FORGINGS

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
BOEING	LONG	43.3
		44.9
		43.1
	AVERAGE	43.8
	STANDARD DEVIATION	1.0

TABLE C9

BEARING RESULTS FOR PECHINEY

2091-T6 FORGINGS

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING	LONG	1.5	73.9	65.6
			82.7	65.9
			85.5	72.3
NORTHROP	LONG	1.5	103.8	87.7
			95.0	81.8
			99.8	82.2
LOCKHEED, GEORGIA	LONG	1.5	95.3	84.7
			99.0	85.7
			102.2	86.3
		AVERAGE	93.0	79.1
		STANDARD DEVIATION	10.1	8.8

NOTE: NORTHROP SPECIMENS REMOVED FROM FORGING SIDE WALL.

TABLE C10

BEARING RESULTS FOR PECHINEY

2091-T6 FORGINGS

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING	LONG	2.0	142.3	105.3
			144.9	112.9
			142.0	105.7
NORTHROP	LONG	2.0	134.8	104.3
			139.6	105.1
			136.4	105.0
GENERAL DYNAMICS, TEXAS	LONG	2.0	129.0	116.0
LOCKHEED, GEORGIA	LONG	2.0	129.2	108.8
			128.1	105.1
			132.8	109.2
		AVERAGE	135.9	107.7
		STANDARD DEVIATION	6.1	4.0

NOTE: NORTHROP SPECIMENS REMOVED FROM FORGING SIDE WALL.

TABLE C11

BEARING RESULTS FOR PECHINEY

2091-T6 FORGINGS

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
GENERAL DYNAMICS, TEXAS	L TRANS	2.0	128.0	87.2
		AVERAGE	128.0	87.2
		STANDARD DEVIATION		

TABLE C12

FRACTURE TOUGHNESS RESULTS FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	ORIENTATION	KIC (KSI IN^0.5)	Kq (KSI IN^0.5)	COMMENT
NORTHROP	L-T		29.1	(1),(3),(4)
			22.2	(2),(3),(4)
MARTIN MARIETTA, LOUISIANA	L-T		25.8	(4),(5)
			27.6	(4),(5)
	AVERAGE		26.2	
	STANDARD DEVIATION		3.0	

(1): W=1.0
(2): W=0.8
(3): SPECIMEN REMOVED FROM FORGING BASE
(4): INVALID
(5): VIOLATES SPECIMEN THICKNESS REQUIREMENTS

TABLE C13

FRACTURE TOUGHNESS RESULTS FOR

PECHINEY 2091-T6 FORGINGS

COMPANY	ORIENTATION	KIC (KSI IN^0.5)	Kq (KSI IN^0.5)	COMMENT
NORTHROP	T-L		24.1	(1),(3),(4)
			27.4	(2),(3),(4)
GENERAL DYNAMICS, TEXAS	T-L		25.9	(5)
			20.4	(5)
MARTIN MARIETTA, LOUISIANA	T-L		22.0	(4),(7)
			25.3	(4),(7)
	AVERAGE		24.2	
	STANDARD DEVIATION		2.6	

(1): W=1.0
(2): W=0.8
(3): SPECIMEN REMOVED FROM FORGING BASE
(4): INVALID
(5): INVALID DUE TO - INSUFFICIENT THICKNESS, Pmax/Pq > 1.10, AND MINIMUM SURFACE CRACK LENGTH < 90%
(6): INVALID DUE TO - Pmax/Pq > 1.10, MINIMUM SURFACE CRACK LENGTH < 90%, AND CRACK CURVATURE > 5%
(7): VIOLATES SPECIMEN THICKNESS REQUIREMENTS

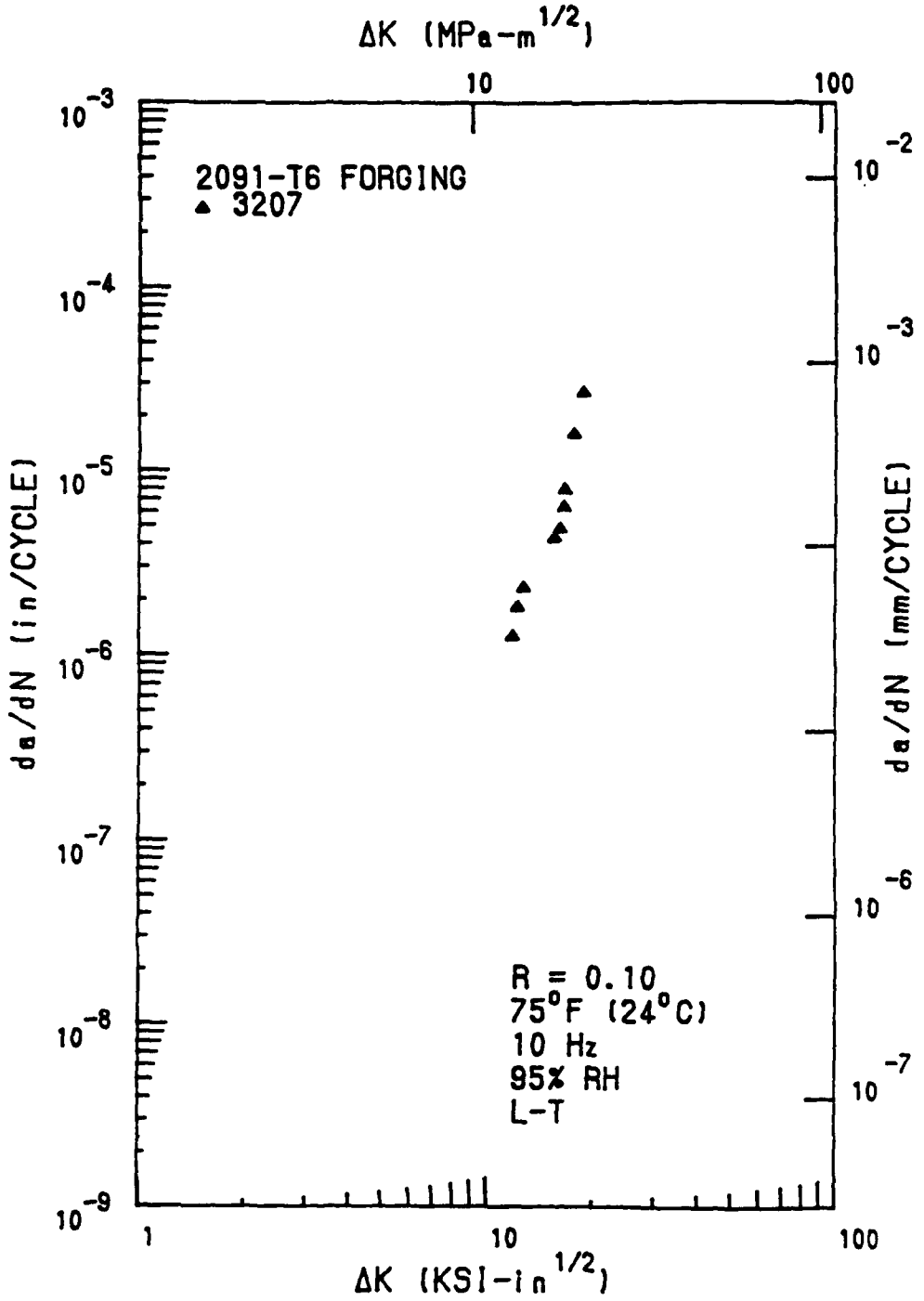


Figure C2 Fatigue Crack Growth Rate Data for Pechiney 2091-T6 Forging (L-T Orientation). Northrop.

TABLE C14

Fatigue Crack Growth Rate Data
Associated with Figure C2

Seven Point Incremental Polynomial Method per ASTM E647

09-27-1989

Specimen Number: 3207 Specimen Type: CT

B= 0.2520 in W= 2.0250 in An= 0.0000

Pmax= 850.0 lbs Pmin= 85.0 lbs

R= 0.10 Frequency= 10.00 hz.

Test Temperature= 75 F Environment= 95% RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.4615				
2	100.00	0.4795				
3	194.00	0.5125				
4	326.10	0.5810	0.5983	0.916447	11.85	.1260E-05
5	352.00	0.5995	0.6225	0.959535	12.22	.1805E-05
6	373.70	0.6300	0.6504	0.992076	12.66	.2306E-05
7	432.00	0.8128	0.8124	0.999865	15.58	.4251E-05
8	437.00	0.8328	0.8348	0.999543	16.04	.4761E-05
9	441.00	0.8510	0.8569	0.991889	16.52	.6302E-05
10	443.50	0.8660	0.8613	0.978287	16.62	.7829E-05
11	449.00	0.8995	0.9058	0.964758	17.66	.1582E-04
12	452.00	0.9460	0.9490	0.974070	18.76	.2670E-04
13	455.00	1.0120				
14	457.00	1.1170				
15	458.00	1.2000				

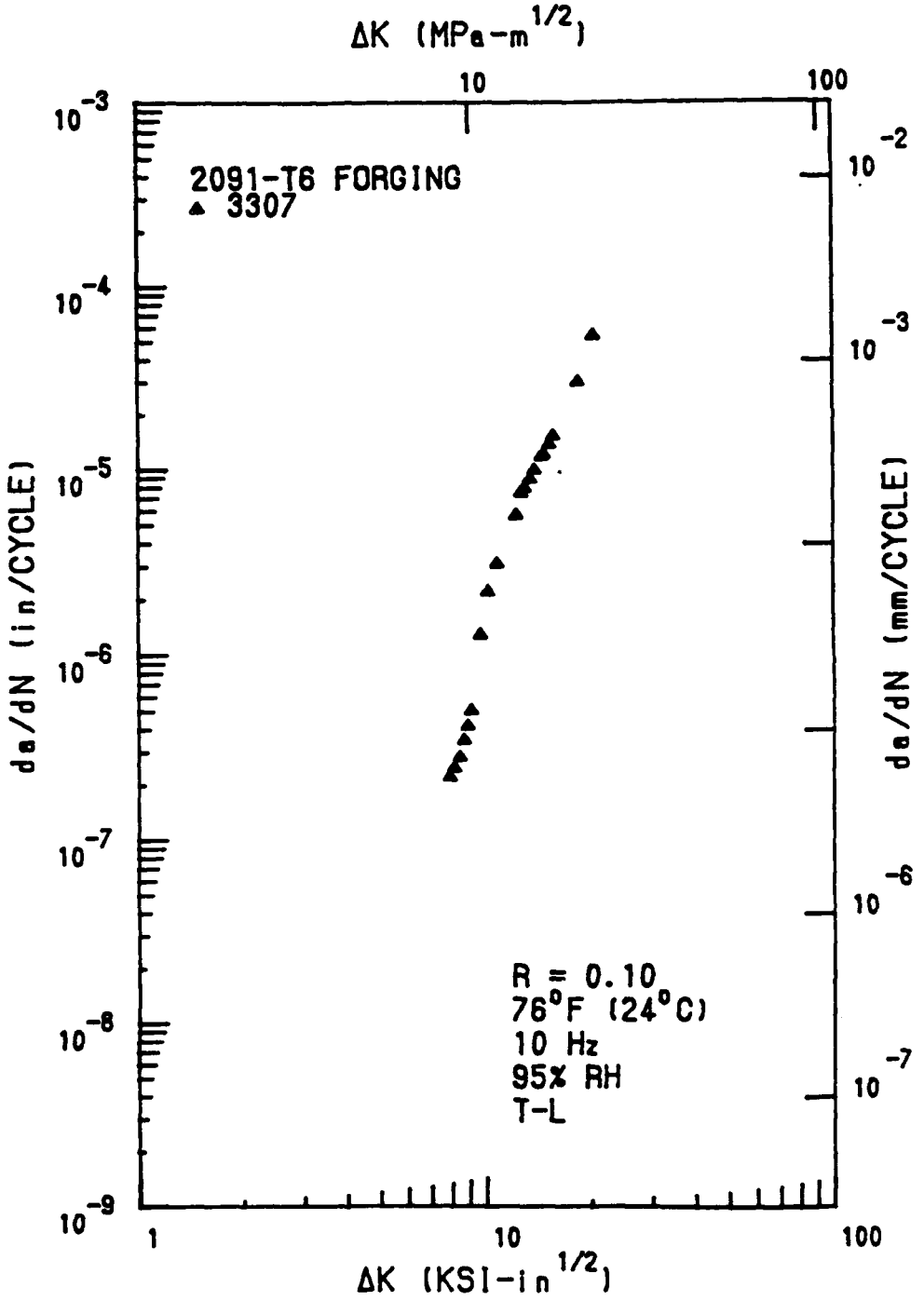


Figure C3 Fatigue Crack Growth Rate Data for Pechiney 2091-T6 Forging (T-L Orientation). Northrop.

TABLE C15

Fatigue Crack Growth Rate Data Associated with Figure C5

Seven Point Incremental Polynomial Method per ASTM E647

09-27-1989

Specimen Number: 3307 Specimen Type: CT

B= 0.2500 in W= 2.0020 in An= 0.0000

Pmax= 560.0 lbs Pmin= 56.0 lbs

R= 0.10 Frequency= 10.00 hz.

Test Temperature= 76 F Environment= 95% RH

PT	CYCLES	Ameas	Areg	MCC	Delta K	da/dN
1	0.00	0.4985				
2	168.00	0.5055				
3	368.00	0.5200				
4	814.00	0.5975	0.5950	0.999616	7.95	.2181E-06
5	914.00	0.6175	0.6183	0.999504	8.19	.2455E-06
6	1014.00	0.6430	0.6448	0.998416	8.48	.2798E-06
7	1100.00	0.6670	0.6681	0.999107	8.73	.3465E-06
8	1150.00	0.6845	0.6854	0.995776	8.93	.4145E-06
9	1192.00	0.7025	0.7012	0.988609	9.11	.5023E-06
10	1280.00	0.7435	0.7522	0.907554	9.73	.1273E-05
11	1310.00	0.7715	0.7884	0.942234	10.20	.2186E-05
12	1330.00	0.8000	0.8332	0.966970	10.83	.3099E-05
13	1355.00	0.9150	0.9226	0.993375	12.25	.5622E-05
14	1359.00	0.9445	0.9455	0.999493	12.67	.7386E-05
15	1361.20	0.9610	0.9613	0.999589	12.96	.7894E-05
16	1364.00	0.9840	0.9846	0.994968	13.42	.8860E-05
17	1366.20	1.0060	1.0036	0.993728	13.82	.9919E-05
18	1369.20	1.0280	1.0352	0.994112	14.52	.1174E-04
19	1370.00	1.0475	1.0448	0.996247	14.74	.1194E-04
20	1371.70	1.0680	1.0640	0.988877	15.21	.1364E-04
21	1373.20	1.0875	1.0818	0.984883	15.67	.1515E-04
22	1378.00	1.1590	1.1748	0.983163	18.49	.3012E-04
23	1379.50	1.2160	1.2273	0.973899	20.50	.5377E-04
24	1380.00	1.2425				
25	1380.50	1.2770				
26	1381.00	1.3425				

* - DATA VIOLATES SIZE REQUIREMENTS

APPENDIX D

PECHINEY

8090-T651 T-EXTRUSION

INTRODUCTION

The Pechiney 8090-T651 T-Extrusion was received the fourth quarter of 1986. Dimensions of the T-Extrusion are 0.19" x 2.5" x 3.0" x 79". Four participants tested this material; Boeing Commercial Airplane Company WA, General Dynamics Fort Worth Division, LTV Aircraft Products Group TX, and the Navy (Naval Air Development Center).

TESTING

Basic mechanical properties (tension, compression, bearing, etc.) were tested according to ASTM standards, unless otherwise specified.

TABLE D1
TENSILE RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
BOEING	RT	LONG	77.4	66.9	8.0		
			77.5	67.0	8.0		
			77.4	67.0	8.0		
GENERAL DYNAMICS, TEXAS	RT	LONG	81.0	71.5	5.9		
			77.1	68.3	2.9		
			80.3	70.5	5.7		
			80.7	70.9	4.9		
NADC	RT	LONG	76.0	66.9	3.0		10.4
			81.2	72.4	3.0		11.5
			80.7	71.3	3.0		10.0
			82.2	72.4	3.0		9.5
LTV	RT	LONG	78.5	68.9	6.1		11.6
			77.4	68.5	7.2		11.6
			78.5	69.2	6.9		11.6
		AVERAGE	79.0	69.4	5.4		10.9
	STANDARD DEVIATION		2.0	2.1	2.1		0.9

TABLE D2
TENSILE RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENT-ATION	ULTIMATE STRENGTH (KSI)	YIELD STRENGTH (KSI)	ELONG (%)	RA (%)	E (MSI)
GENERAL DYNAMICS, TEXAS	RT	L TRANS	78.4	69.5	4.4		
			78.2	69.6	4.5		
		AVERAGE	78.3	69.6	4.5		
	STANDARD DEVIATION		0.1	0.1	0.1		

TABLE D3
COMPRESSION RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	TEST TEMPERATURE (DEGREES F)	ORIENTATION	COMPRESSIVE YIELD STRENGTH (KSI)	COMPRESSIVE MODULUS (MSI)
BOEING	RT	LONG	68.0	
			67.1	
			67.7	
		AVERAGE	67.6	
		STANDARD DEVIATION	0.5	

TABLE D4
SLOTTED SHEAR RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
BOEING	LONG	42.5
		42.5
		42.5
	AVERAGE	42.5
	STANDARD DEVIATION	0.0

TABLE D5
SLOTTED SHEAR RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
GENERAL DYNAMICS, TEXAS	L TRANS	41.7
		41.2
	AVERAGE	41.5
	STANDARD DEVIATION	0.4

TABLE D6
IOSIPESCU SHEAR RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
LTV	LONG	41.4
		40.6
		42.5
	AVERAGE	41.5
	STANDARD DEVIATION	1.0

TABLE D7
IOSIPESCU SHEAR RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	ORIENTATION	SHEAR STRENGTH (KSI)
LTV	L TRANS	39.5
		40.4
		39.3
	AVERAGE	39.7
	STANDARD DEVIATION	0.6

TABLE D8
BEARING RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING	LONG	1.5	103.4	90.2
			106.5	94.6 *
			107.6	95.5 *
GENERAL DYNAMICS, TEXAS	LONG	1.5	106.0	94.3
			104.0	91.2
LTV	LONG	1.5	105.5	97.4
			107.0	96.2
			106.2	93.3
		AVERAGE	105.8	94.1
		STANDARD DEVIATION	1.4	2.4

(*): INDICATES SHEAR TEAR OUT FAILURE

TABLE D9
BEARING RESULTS FOR PECHINEY

8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	ORIENTATION	e/D	BEARING ULT. STR. (KSI)	BEARING YIELD STR. (KSI)
BOEING	LONG	2.0	131.8	105.1 *
			138.6	113.1 *
			135.2	111.4 *
GENERAL DYNAMICS, TEXAS	LONG	2.0	116.0	106.0
			135.0	107.0
LTV	LONG	2.0	135.6	116.4
			136.0	
			133.6	111.2
		AVERAGE	132.7	110.0
		STANDARD DEVIATION	7.0	4.1

(*): INDICATES SHEAR-TENSION FAILURE

TABLE D10
FATIGUE RESULTS WITH R=0.1 AND Kt=2.8 FOR

PECHINEY 8090-T651 T-EXTRUSION (0.19" X 2.5" X 3" X 79")

COMPANY	ORIENTATION	STRESS (KSI)	CYCLES
LTV	LONG	22.0	54,800
		22.0	58,700
		21.2	83,700
		19.6	213,900
		19.5	73,800
		19.5	176,700
		17.3	219,100
		16.5	212,300
		16.0	300,200
		15.0	341,600
		14.9	1,000,000 *

(*): INDICATES A RUN-OUT TEST

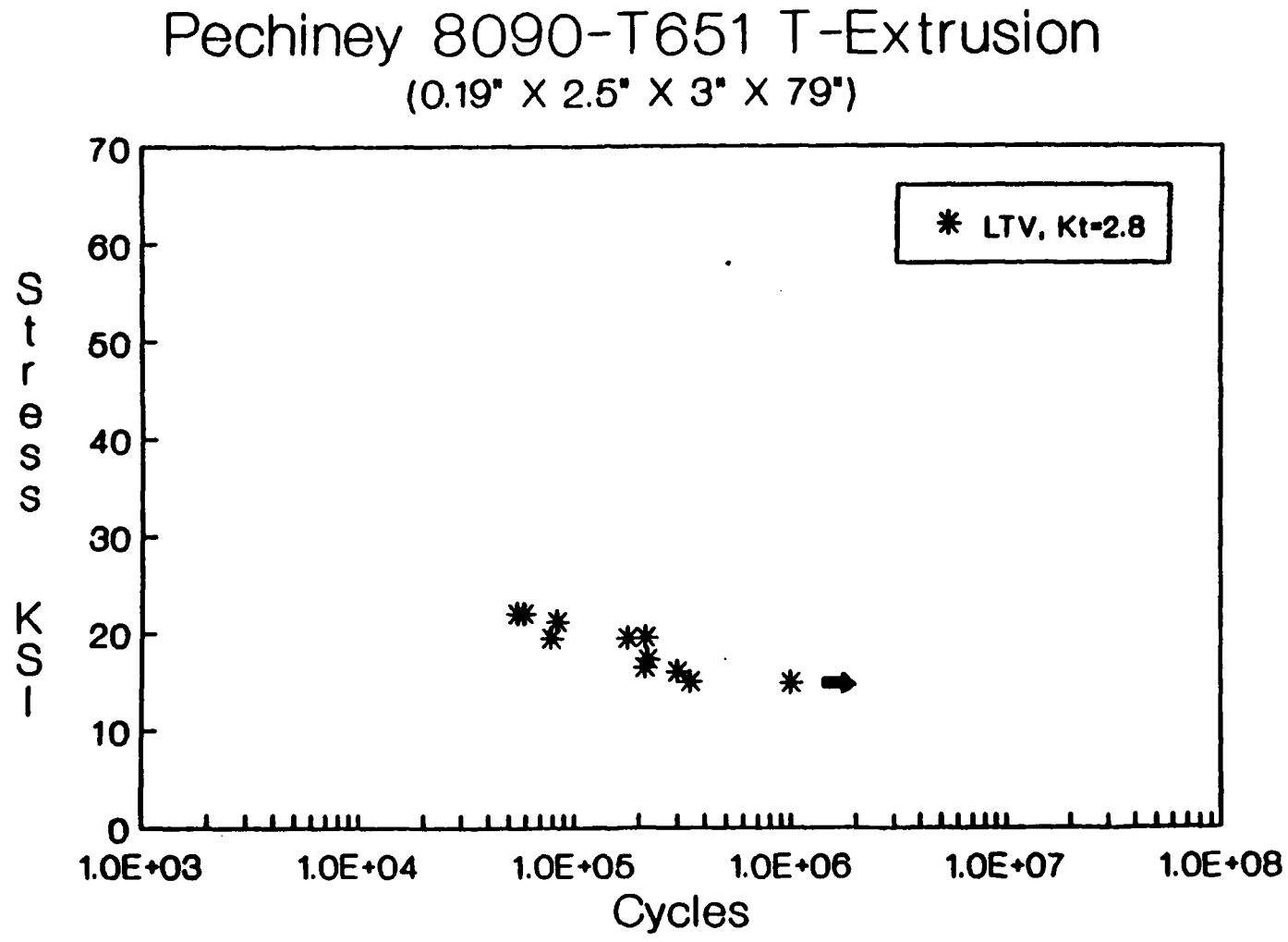


Figure D1 Fatigue Results for 8090-T651 T-Extrusion (R=0.1, Kt=2.8). LTV.